POWER

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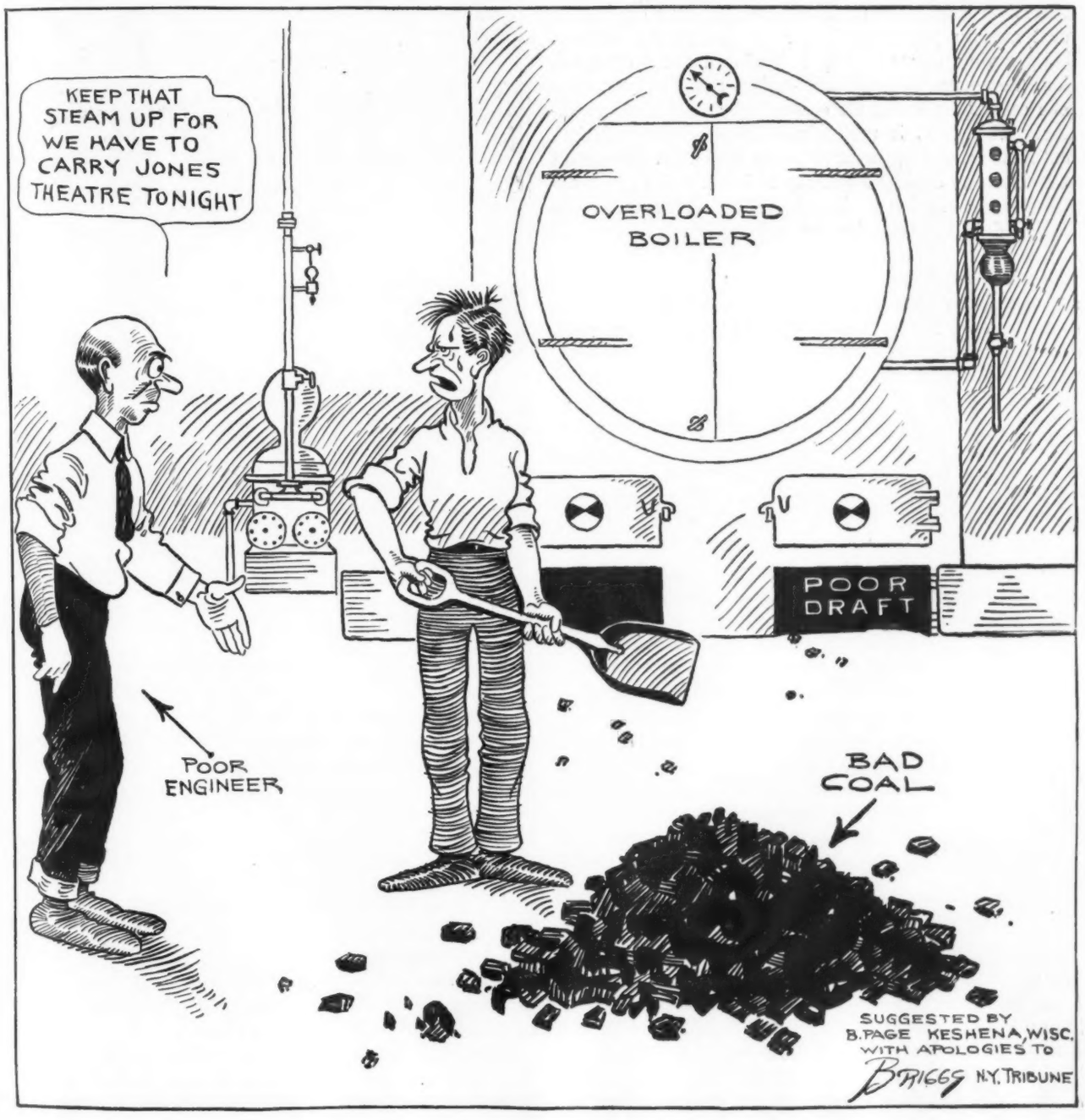
When a Fellow Needs a Friend


KEEP THAT STEAM UP FOR WE HAVE TO CARRY JONES THEATRE TONIGHT
OVERLOADED BOILER
POOR DRAFT
POOR ENGINEER
BAD COAL
SUGGESTED BY B. PAGE KESHENA, WISC. WITH APOLOGIES TO
BRIGGS N.Y. TRIBUNE

Power Plant at Kincaid, Ill.

By Thomas Wilson

SYNOPSIS—New 6000-kw. turbine plant of the Central Illinois Public Service Co. furnishes power to mines and power and light to surrounding towns. Notable features are: Coal-handling facilities, smoke flue on roof, control of makeup water and provisions for storing and cooling condenser circulating water.

Near the industrial town of Kincaid, Ill., recently established by the Peabody Coal Co. for its miners, the Central Illinois Public Service Co. has built one of the most modern power plants for its size in the country. The building, shown in Fig. 1, is of substantial construction, the equipment is of late design, and the layout has been carefully planned for convenient and efficient operation. The plant is maintained in excellent condition, and if its general appearance is any indication the overall economy is no doubt close to the best obtainable under existing load conditions. At this writing, however, no operating data are available for publication.

The plant was established to serve the surrounding towns and the Peabody mines in the vicinity, all of which are electrically operated. Electric locomotives haul the coal, and even the hoisting is done by motor. The plant now serves six mines, the largest of which is the Nokomis, requiring a maximum load of 1500 kw. With the exception of the power for ventilation, practically all of the mine load comes between 8 a.m. and 4 p.m. With the day load secured and the location of the plant determined, it was evident that commercial lighting would greatly improve the load factor and call for continuous operation in the power plant. Twenty different towns now take service. The load at the peak runs up to 3300 kw. For the month of December the total output was 900,000-kw.-hr. It is expected, however, that both lighting and power loads will soon be materially increased. A blank wall closes in the east end of the station, and provisions have been made for a possible extension of the plant to double its present size. It now has a generating capacity of 6000 kw., made up of three turbo-generator units, two of 2500-kw. (Fig. 2) and a third of 1000-kw. capacity. These machines are supplied with steam by six water-tube boilers having a combined rating of 2700 hp., a ratio of 1 boiler horsepower to 1.85 kw. of generating capacity. There are several features, such as the coal handling, the location of the smoke flue and the condenser cooling water which are of interest and will be taken up in turn.

Boiler Installation

Four of the boilers contain 5000 sq.ft. of heating surface each and two 3500 sq.ft. Chain grates, with areas of 103.5 and 69 sq.ft. respectively, serve the boilers, and in the same order the ratios of grate to heating surface are 1 to 48 and 1 to 51. The boilers are of the three-pass type, vertically baffled and installed with a height of 10 ft. from the floor to the bottom of the front tube-header. The ignition arch, which is 8 ft. long, is horizontal, and its highest point is 23 in. above the grate. A 39-in. throat admits the gases to the first pass, and at the rear the uptake is around the drums directly upward into the smoke flue. The boiler damper is in the uptake at the entrance to the flue. The uptake is liberally proportioned. For the larger boilers it has an area of 27 sq.ft. Comparing this to the grate surface, the ratio is about 1 to 4. The walls of the setting are corbeled to provide sufficient area around the drums. In comparison with passing the gases out at the rear, this construction does away with one, and frequently two, right-angled turns between the third pass and the breeching. For vertically baffled boilers the arrangement mentioned is preferable and in recent years has been quite generally adopted.

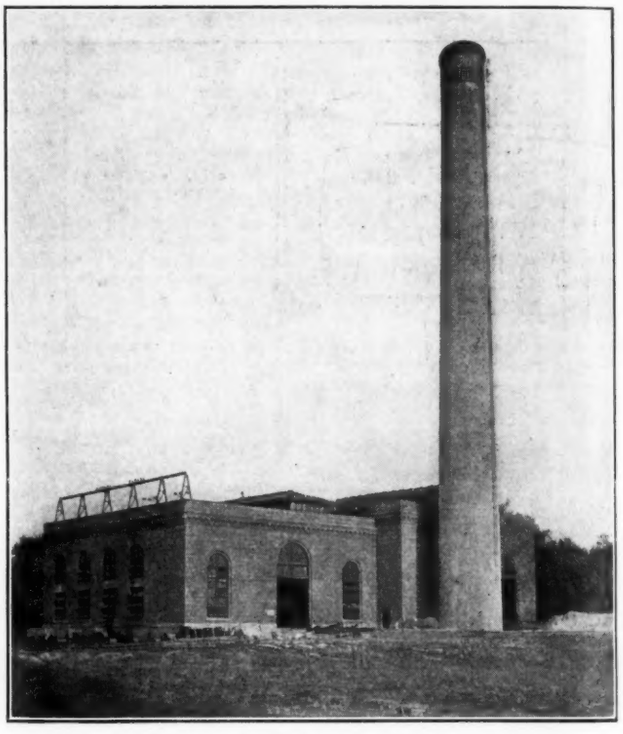


FIG. 1. KINCAID POWER PLANT OF CENTRAL ILLINOIS PUBLIC SERVICE CO.

To save headroom and so that it will not interfere with the piping, the smoke flue has been located on the boiler-room roof. Its support is arranged to provide the special ventilator shown at the right of the flue, which reduces the temperature above the boilers. The flue is of tapering section, has parallel vertical walls, a semicircular top, and a straight run of approximately 105 ft. into the stack. The construction is steel plate with a 4½-in. brick lining. At the outlet its sectional area is 155 sq.ft., which may be compared to an area of 133 sq.ft. for the stack, a reduction of 14 per cent. The stack is 13 ft. in diameter, rises 200 ft. above the boiler-room floor and is made of reinforced concrete, firebrick lined.

Allowing a drop of 0.2 in. per 100 ft. length of smoke flue, 0.05 in. for each right-angled turn, 0.05 in. for interference from each boiler and a 50-per cent. drop through the damper and setting, the draft over the fire should range from 0.4 in. for the boiler farthest from the stack to 0.5 in. for the first boiler, the temperature of the gases

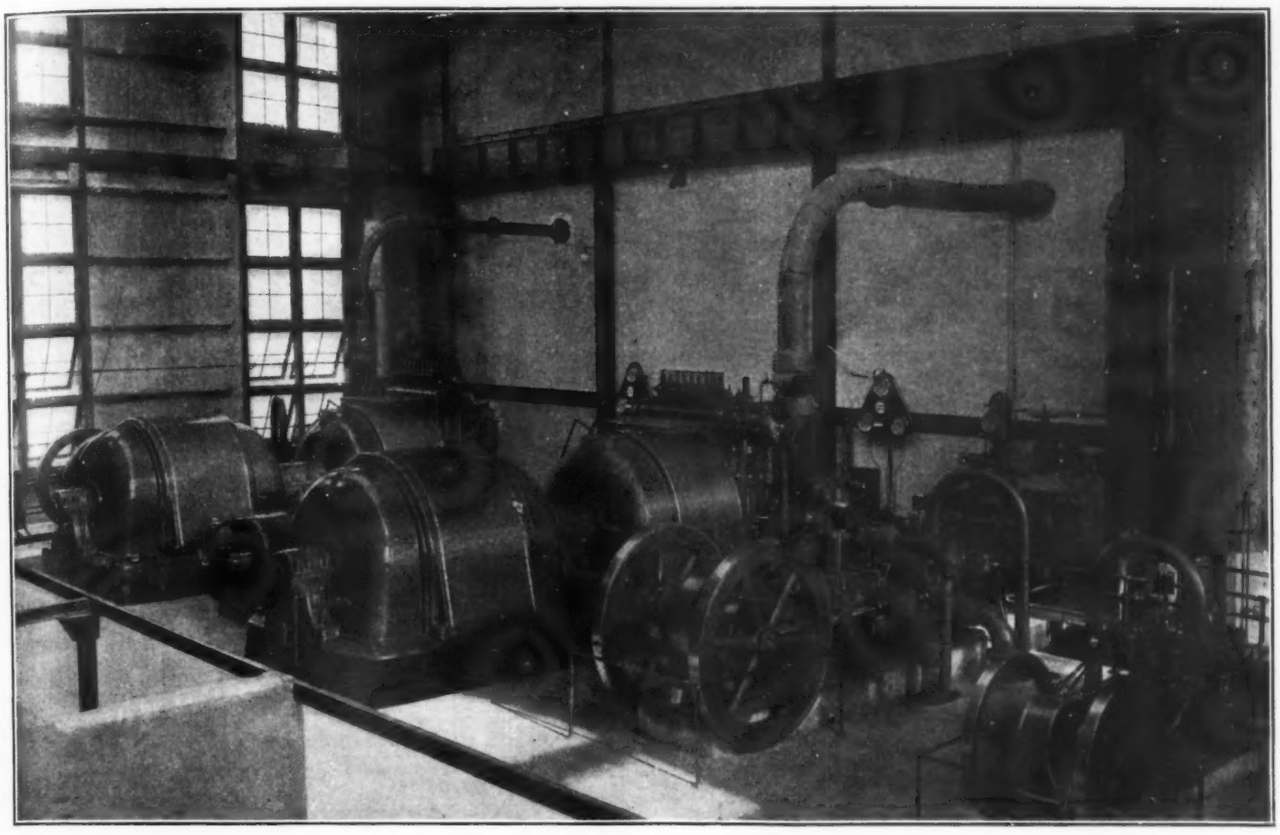


FIG. 2. THE TWO 2,500-KW. GENERATING UNITS

being 500 deg. This gives a wide range of damper control, provides for varying thicknesses of fuel bed and for high rates of combustion when it is necessary to force the boilers. The operating pressure is 190 lb. gage, and by large loop tubes the steam is superheated 150 deg.

Reviewing the areas mentioned, the following ratios are obtained. For every 1000 sq.ft. of heating surface there are practically 20 sq.ft. of grate, 5.74 sq.ft. of breeching, and 5 sq.ft. of stack. Each square foot of breeching area serves 3.5 sq.ft. of connected grate, and the stack per unit of grate area is 4.1 sq.ft.

For fuel, 1¼-in. screenings are used. The coal is obtained from Peabody mines Nos. 7 or 8, one-quarter mile distant from the plant. As shown in Figs. 3 and 4, it is brought directly into the boiler room in railway cars, from which it may be transferred to the coal hoppers for the stokers or to a concrete storage pit under the track and running the length of the boiler room. An electrically operated traveling crane equipped with a 2-yd. grab bucket raises the coal from the car or storage to the hoppers. While suspended in the bucket it is weighed by a track scale. With the proper type of car the coal can be

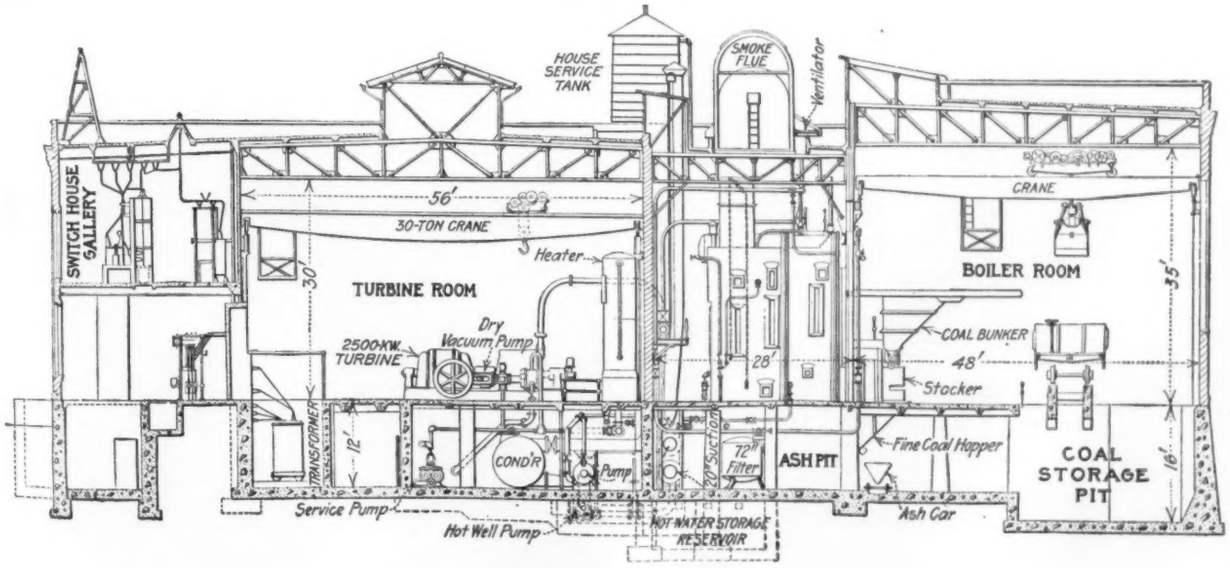


FIG. 3. SECTIONAL ELEVATION OF PLANT

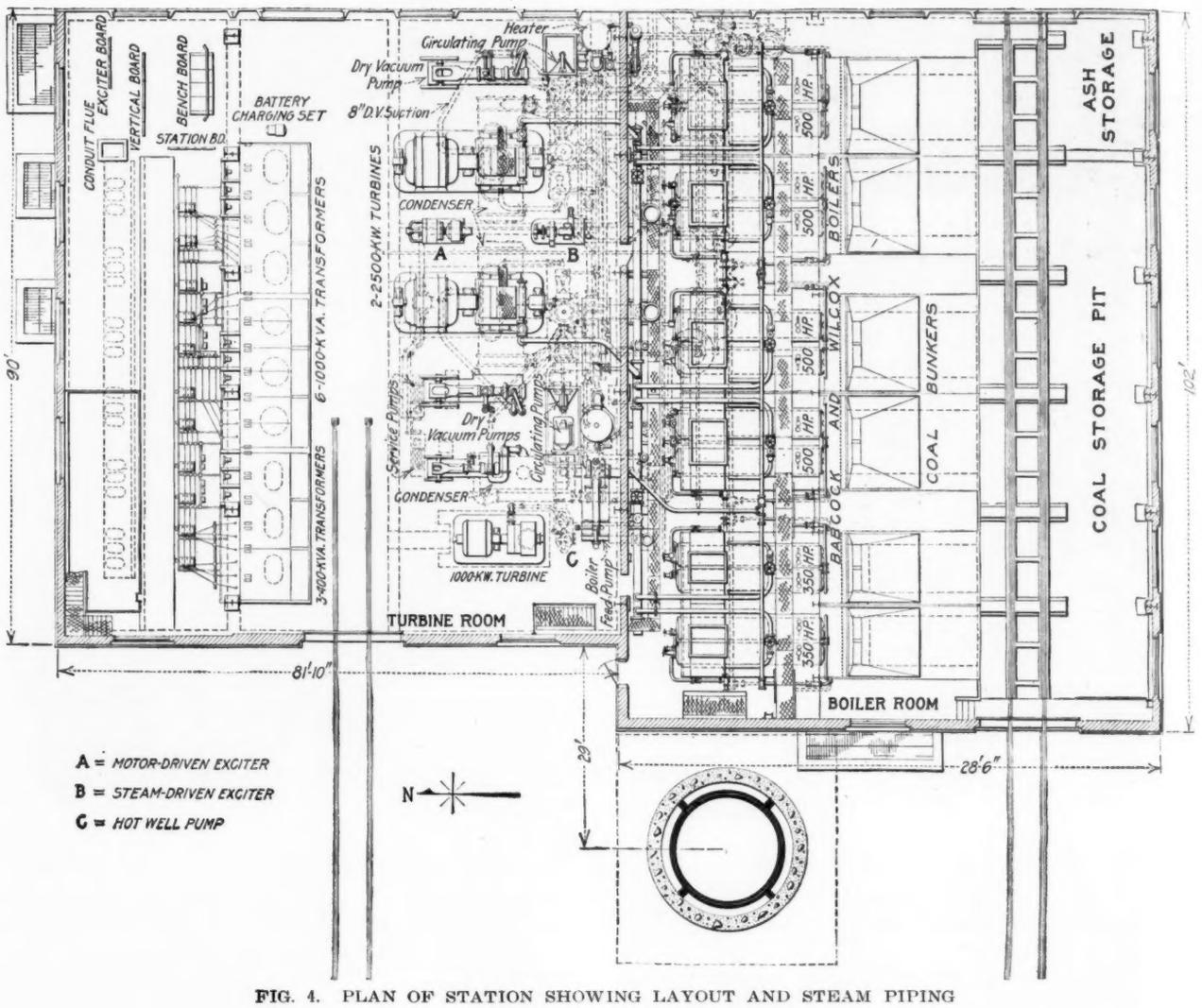


FIG. 4. PLAN OF STATION SHOWING LAYOUT AND STEAM PIPING

dumped directly into storage or be unloaded by the crane from the nondumping type.

Part of the pit is walled off for ash storage. Industrial cars are used to transfer the ashes from the hoppers under the stokers, and the crane loads the accumulated supply into the empty coal cars. Into the ashpit under the furnace a soot chute leads from the space back of the bridge-wall, and under the grate there is a fine-coal hopper which may be discharged into the industrial ash cars.

Generating Units

As previously stated, the generating equipment consists of two 2500- and one 1000-kw. units. The larger turbines

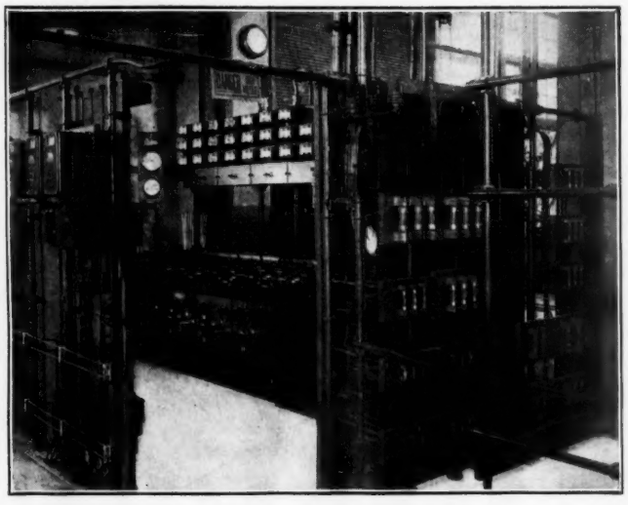


FIG. 5. CONTROL AND BENCH BOARDS

FIG. 6. LOW-TENSION BUS STRUCTURE

FIG. 7. COOLING POND AND SPRAY NOZZLES IN ACTION

operate at a speed of 1800, and the smaller one at 3600 r.p.m. The generators are three-phase, 60-cycle, 2300-volt machines supplied with excitation by either a motor- or a turbine-driven exciter.

From the generators the current goes to the low-tension 2300-volt bus which feeds the town of Kincaid proper. It is stepped up through three banks of water-cooled transformers, delta connected on both sides, to 33,000 volts and delivered to the high-tension bus. There are two outgoing 33,000-volt lines with space for two more. The construction and equipment are standard. Both busses are of the open type, the oil switches are under solenoid control and the potential transformers are placed in masonry compartments. Figs. 5 and 6 show the switchboards and the low-tension bus structure respectively.

Steam piping supplying the large units is 8 in. in diameter. With the rated, or maximum, load on the machine the size was apparently figured for a velocity of steam approximating 6000 ft. per min. For turbines this is conservative practice, giving a pipe of ample proportions. The exhaust, 48 in. in diameter, has a sectional area of 12.566 sq.ft., which at 28.5 in. of vacuum calls for a velocity of about 22,500 ft. per min. into the condenser.

During the summer months a vacuum of about 28.4 in. is maintained, and during the winter the colder water makes possible a vacuum close to 29 in. The condensers are of the surface type equipped with 1-in. tubes. The larger have 7200 sq.ft. of surface and the condenser for the small unit 3200. Per kilowatt of generating capacity the surface reduces to 2.88 and 3.2 sq.ft. respectively. Under normal operating conditions each square foot must condense about 5 lb. of steam. Each of the large circulating pumps has a capacity of 7000 gal. per min. and at normal load is capable of supplying 95 lb. of water per pound of steam in the condenser.

Condenser Cooling Water

Cooling water for the condensers may be taken from the south fork of the Sangamon River, which is dammed a little farther down-stream to conserve the supply. The muddy water has a chance to settle as it lies in the reservoir formed by the dam. Normally, the circulating pumps draw from the river and discharge above the dam. On account of the rise in temperature of the water in the summer months it was thought advisable to provide a cooling pond and spray nozzles. In all, there are 96 three-inch nozzles arranged in eight rows of 12 each. The arrangement is shown in Fig. 7. The pond is located 200 ft. east of the plant. An intake crib connecting with the river and also with the pond is located 75 ft. west of the

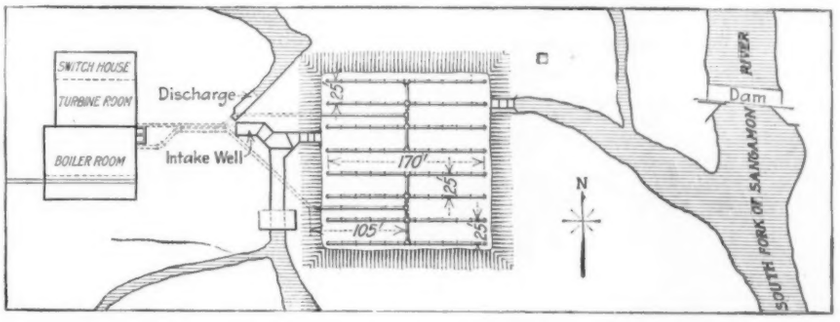


FIG. 8. WATER SUPPLY AND LOCATION OF COOLING POND

PRINCIPAL EQUIPMENT OF KINCAID POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Horizontal water-tube	500-hp	Generate steam	190 lb. pressure, 150 deg. superheat	Babcock & Wilcox Co.
2	Boilers	Horizontal water-tube	350-hp	Generate steam	190 lb. pressure, 150 deg. superheat	Babcock & Wilcox Co.
4	Stokers	Chain-grate	103.5-sq.ft.	Serve 500-hp. boilers		Babcock & Wilcox Co.
2	Stokers	Chain-grate	69-sq.ft.	Serve 350-hp. boilers		Babcock & Wilcox Co.
1	Stack	Reinforced concrete	200 ft. high, 13 ft. diam.	Serves six boilers		General Concrete Construction Co.
1	Crane	Traveling	2-yard grab-bucket	Handles coal and ash	Electrically operated	Toledo Bridge & Crane Co.
2	Pumps	Duplex	12x8x18-in.	Boiler-feed pumps	196 lb. steam	Henry R. Worthington
1	Heater	Open	100,000 lb. per hr. from 70 to 200 deg.	Heats feed water	Exhaust from auxiliaries	Platt Iron Works Co.
2	Turbines	Horizontal-impulse	2500-kw.	Main units	190 lb. steam, 150 deg. superheat, 1800 r.p.m.	General Electric Co.
2	Generators	Three-phase, 60-cycle	2500-kw.	Main units	2300-volt, 1800 r.p.m.	General Electric Co.
2	Condensers	Surface	7200-sq.ft.	Serve 2500-kw. turbines	Vacuum 28.4 to 29 in.	Henry R. Worthington
2	Pumps	Centrifugal	14-in.	Circulating condenser water	Turbine-driven, capacity 7000 gal. per min.	Henry R. Worthington
2	Pumps	Rotative type	10x19x18-in.	Dry-vacuum pumps	190 lb. steam	Henry R. Worthington
2	Pumps	Centrifugal	2½-in.	Hot-well	Turbine-driven, capacity 120 gal. per min.	Henry R. Worthington
1	Turbine	Horizontal-impulse	1000-kw.	Main unit	190 lb. steam, 150 deg. superheat, 3600 r.p.m.	General Electric Co.
1	Generator	Three-phase, 60 cycle	1000-kw.	Main unit	2300-volt, 3600 r.p.m.	General Electric Co.
1	Condenser	Surface	3200-sq.ft.	Serves 1000-kw. turbine	Vacuum 28.4 to 29 in.	Henry R. Worthington
1	Pump	Centrifugal	10-in.	Circulating condenser water	Turbine-driven, 3000 gal. per min.	Henry R. Worthington
1	Pump	Rotative type	8x16x12-in.	Dry-vacuum pump	190 lb. steam	Henry R. Worthington
1	Pump	Centrifugal	1½-in.	Hot-well	Turbine-driven, 55 gal. per min.	Henry R. Worthington
1	Exciter	Direct-driven	75-kw.		Turbine-driven, 125-volt, 3300 r.p.m.	General Electric Co.
1	Exciter	Direct-driven	75-kw.		Motor-driven, 125-volt, 1200 r.p.m.	General Electric Co.
2	Pumps	Reciprocating	7½x10½x10-in.	Service	190 lb. steam, 75 lb. water discharge	Henry R. Worthington
1	Filter	Pressure	6 ft. diam. x 7 ft. high	Filters boiler make-up	Cap. 70 gal. per min.	Jewel Water Improvement Co.
1	Crane	Traveling	30-ton	Serves engine room		Toledo Bridge & Crane Co.
96	Spray nozzles		3-in.	Cool condenser water		Schutte & Koerting Co.
1	Scale	Track		Weighs coal		Howe Scale Co.

latter. A concrete tunnel connects it with a well at the plant from which the pumps draw their supply. As shown in Fig. 8, the discharge may go back to the river or it may pass through the spray nozzles to the cooling pond, as desired.

Makeup Water-Supply

Most of the boiler feed is condensate from the condensers. There is, of course, some loss and a small percentage of makeup water is needed. The main source is a large concrete reservoir, which receives all the warm water from the bearings of the main units and the clean drips from the steam piping. The water level is maintained at a certain height by a float connection from the service header. From the reservoir the water is drawn into the condensers by the vacuum, a valve operated by a float located in the feed-water heater controlling the amount of water.

The service header is a secondary source of supply that may be drawn on directly for make-up water. River or pond water is drawn from the intake well by either of two service pumps and elevated to the service header and a house tank on the roof. From the header the water may pass by gravity through a filter and settling tank to the heater, a second float in the latter regulating the supply. The main float, being at a higher level, opens first, and if the system which it controls should fail, the auxiliary float lower down will eventually act and admit makeup from the header.

The heaters are of the open type, taking exhaust steam from the auxiliaries. Each has a capacity to heat 100,000 lb. of water per hour from 70 to 200 deg. Feed for the boilers is supplied by either one or two duplex pumps, each having a capacity of 250 gal. per min. Pump governors control their operation.

Sargent & Lundy, consulting engineers, of Chicago, designed the plant, M. E. Sampsell is president of the service company, and L. S. Johnson is chief engineer in charge of operation.

Perpetual Motion, Then Some

Following are some choice paragraphs from a statement by the inventor, as reported in a Washington Sunday paper, describing his scheme to separate water into hydrogen and oxygen and use the two gases to operate an internal-combustion engine:

"Water, when used as an explosive power, is far more powerful than gasoline, naphtha or kerosene. The explosive power of the gases develops 89.87 per cent. horsepower" (whatever that may mean). "This oxygen and hydrogen is separated from its natural source by means of 'electrolis.' Current from a six-volt battery with the help of a small quantity of sulphuric acid, which is put in the water to electrify it, develops the electric power to dissociate the gas. So I think with a little more experimenting water can be used as a fuel for automobiles, marine and stationary motors."

An Engine Indicator the spring of which is in extension instead of compression when pressure is applied to the piston has recently been placed on the market by Dobbie & McInnes, Glasgow, Scotland. This action is accomplished by connecting the lower end of the spring to the cover of the indicator cylinder and the upper end to the piston rod. In other respects the instrument is very similar to the regular outside-spring type.—Mechanical Engineer.

JUST FOR FUN

Only Thought He Knew the Answer

One fellow when asked if he knew how and why a boiler-feed pump would take steam from a boiler and pump water in against the same pressure said: "That is easy. Don't you see that there are three boilers with 125 lb. of steam each? That makes 3 × 125 or 375 lb. working on the steam end of the pump."—Edward O. Edney, Birmingham, Ala.

Absurdity of Assumed Superior Wisdom

The following new definition of cast iron belongs in the "Just for Fun" column. The holder for the "spare tire" on the automobile of a friend of mine was broken and I suggested that it could easily be welded (by the gas process). A young "expert" standing near gave me a withering look. "Weld cast iron? You can't weld that. Why, cast iron is only refuse iron."—Warren D. Lewis, Brooklyn, N. Y.

Another One Wise or Otherwise

There are certainly some funny bonehead stunts pulled off occasionally. The man who had charge of assembling and connecting up a new pump for a test came to me with the information that the pump wouldn't take suction, even after continued priming. I told him to keep on priming and to investigate his piping for leaky joints, etc.; but an hour later he was back with the same tale of woe. He hadn't tumbled yet that he had connected the discharge pipe to the suction opening of the pump, even though it required a reducer, and the suction pipe to the discharge opening.—G. D. Gates, Dubuque, Iowa.

His Pride in High Pressure Had a Fall

A humorous incident was recently related by a boiler inspector. The safety valve was changed to blow at fifteen pounds when the boiler was used for heating only. One cold morning the colored fireman, stoking furiously, watched the steam gage between shovelfuls.

"How is the boiler steaming?" the inspector asked.

"Oh, I'se in a heap o' trouble dis mornin', Boss. The fo'man upstairs he done come down hyar and tol' me da girls was freezing up dar and ah'm doing ma best to get dis pressure up."

"What pressure do you usually carry?"

"Oh, when it am fairly wahm ah carry about 140 poun', but when it am cold lak dis mornin' ah usually carries between 225 and 240 poun's."

Feeling the cold sweat break out on his forehead and the muscles of his throat tighten, it did not ease the inspector's mind to see that the gage was then indicating 215 lb. on the boiler, which he knew was made for 140 lb. fifteen years before. But our hero, a man of courage, gambled with death in pursuit of his duty and bravely held his ground. Questioning revealed the fact that the original high-pressure gage had been taken apart and when put together again had been reversed in such a way that at ten pounds' pressure the hand pointed to 200. The colored stoker was greatly disappointed to find that he had only ten to twelve pounds of steam instead of over 200.—S. P. Stewart, Worcester, Mass.

Boiler-Control Boards at Delray*

By Norman G. Reinbecker

SYNOPSIS—Individual control boards for each boiler unit and a central gage board. The instruments employed and their uses.

In front of each boiler there is a control board upon which are mounted pressure gages, steam-flow meters, draft gages, CO_2 machines, a control switch for damper motors, etc. The control board for the large boilers is

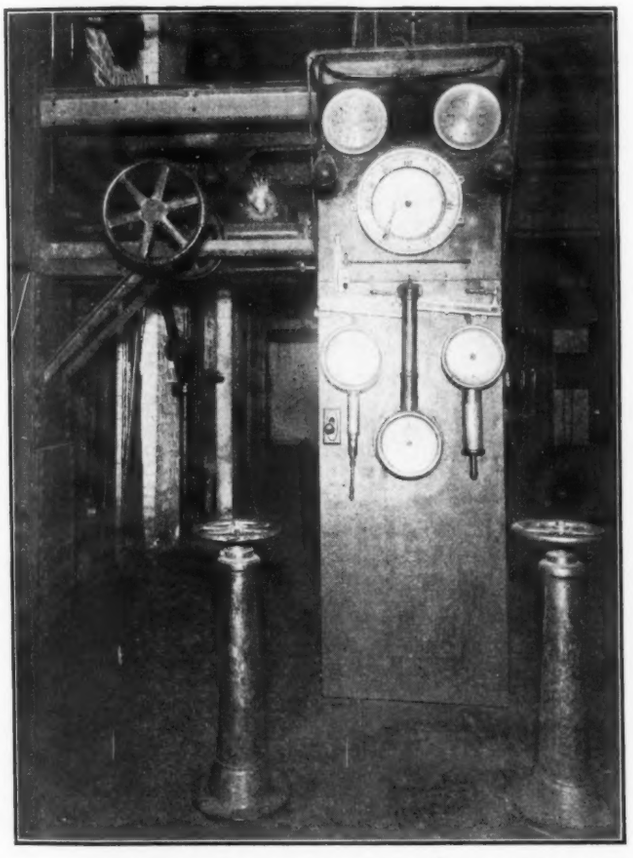


FIG. 1. CONTROL BOARD FOR THE LARGE BOILERS

shown in Fig. 1 and that for the small ones in Fig. 2. Referring to Fig. 1, the gages at the top of the board indicate the pressure in the saturated drum and at the outlet of the superheater. The recording steam-flow meter is connected to a nozzle plug in the discharge pipe from the boiler, the meter being calibrated in thousands of pounds of steam per hour. Just below the steam-flow meter on the left of the board is a small liquid indicating pressure gage which indicates the pressure of the air in the wind box of the stoker in inches of water.

Of the two draft gages, one is connected at the top of the furnace and the other under the damper on the boiler side, so that the difference in readings indicates the drop in draft through the boiler setting, this difference, under like furnace and setting conditions, being a rough measure of the quantity of gas flowing through the setting. The exit gas dampers on the boilers are very large and heavy, so that it is necessary to operate them through a set of worm and bevel gears. Direct-current reversible motors have been put on these dampers, the control being a small, double-throw switch, shown in the lower left-hand corner. This switch is so provided with springs that it automatically returns to a neutral position when the handle is released.

It has been found that best operating results are generally obtained when the draft at the top of the furnace, as indicated by the draft gage on the control board, is kept slightly below atmospheric pressure. The fireman controls his damper to give the desired condition in the furnace. When the gage reading is slightly under atmospheric pressure (say 0.05 in. of water), the actual draft right over the fire may be 0.03 in. of water and sometimes as low as 0.02 in., depending upon the rate of burning the fuel. The combustion chamber in these large boilers is so high that the stack effect in the furnace itself gives ample draft at all times over the fire, with atmospheric pressure or less at the top of the combustion chamber.

Of the remaining three gages on the board one is a Uehling recording CO_2 gage, the machine that operates

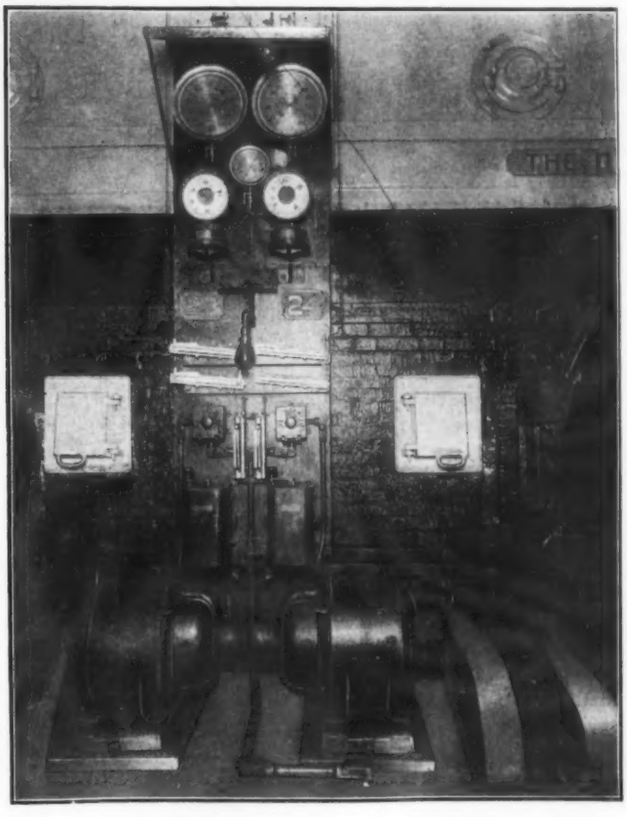


FIG. 2. CONTROL PANEL FOR TWO OF THE SMALLER BOILERS OPERATED AS ONE UNIT

this gage being mounted on a gallery above the boiler-room floor. The other two are recording gages, one showing the draft at the damper and the other the air pressure under the fire.

The two stands in front of the gage board are the extensions of the throttles of steam turbines driving the blowers for furnishing air to the furnaces. The fireman

*See also articles by author on Delray plant, Aug. 31, p. 286, Sept. 7, p. 343, and Sept. 21, p. 414.

varies the speed of the blower to get the necessary quantity of air. The stokers are all driven by variable-speed, direct-current motors provided with drum controllers mounted upon the column nearest the gage board. Beside the controller there is a tachometer which shows the fireman at all times the speed at which his stoker is operating, and this speed is, in the case of the Taylor stoker, a direct indication (for operating purposes at least) of the quantity of coal being put into the furnace.

Control Board for Small Boilers

Fig. 2 shows the control panel for two of the smaller boilers. In power house No. 1 two small boilers and their economizer are operated as a single unit. The control of the air and the fuel for each stoker is separate, because the furnaces are independent. At the top of the board are the pressure gages on the outlets of the superheaters. A

FIG. 3. CENTRAL GAGE BOARD WHICH SHOWS CONDITIONS EXISTING THROUGHOUT THE PLANT

small pressure gage below the larger gages indicates the water pressure in the economizer. The indicating steam-flow meters show the output of the boilers in thousands of pounds of steam per hour. The draft gages are connected at the same relative points in these settings as in the large boiler.

Air for these furnaces is supplied by fans driven by alternating-current constant-speed motors, the quantity of air being controlled by regulating a damper in the discharge of the fan by means of the lever and quadrant attached to the stoker hopper and shown on the right-hand side of Fig. 2. The resulting pressure of the air in the stoker wind box is indicated on the small air-pressure gages shown between and just above the stoker controllers. In this power house it has not been found necessary to install tachometers to read stoker speeds because the operators have learned to use the position of the controller handle as an indication. The CO_2 machines in this boiler room are mounted either at the side or back of the boilers, because of lack of room at the front.

Details of Central Gage Board

The operating engineer has his headquarters at what is known as the "central gage board" in the boiler room of power house No. 2. The function of this gage board, which is shown in Fig. 3, is not unlike that of an electric switchboard, for here the pressure of steam at each turbine and of feed water at various places in the plant, the quantity of feed water and the plant load can be observed, so that the operating engineer can know at all times the conditions existing throughout the plant. Across the top of the board there are pressure gages connected inside the throttles of each of the main turbines. The gages in the next line are connected to the boiler-feed piping system at representative points throughout the system. At the extreme right there are recording pressure gages for the steam and water, and above these a voltmeter on the direct-current system supplying power to drive the stoker motors. The other instruments on the board are venturi meters connected to show the output of the individual boiler-feed pumps.

From this board an observer can follow changing conditions throughout the plant, and in case of accident can locate the trouble quickly. The pressure gages connected to the turbine throttles indicate at all times the machines that are running, and also show the points of low- or high-pressure steam throughout the system. The same is true of the boiler feed-water pressure gages. The sum of the readings of the venturi meters will give the total quantity of water that is being fed to the boilers.

During the time when the stokers are being operated at very low ratings, the voltage of the direct current for stoker motor drive is lowered in order to get a larger range of speed, and to keep a check on this voltage the voltmeter is placed upon the central gage board.

The booth at the left of the board is provided with two telephones. One is an intercommunicating instrument connecting with other telephones throughout the plant and used in connection with operation only, while the other is a Bell telephone connected with the Edison company's exchange. The cans shown in front of the central gage-board inclosure contain the ash and coal samples for each shift. The method of taking these samples will be described in a later article.

Power Plants as Nuisances

By A. L. H. Street

The hazard created against adjoining property through danger of fire or explosion resulting from the operation of steam-power plants in densely settled communities has resulted in the litigation of several interesting cases that have passed to the highest courts of the states and Canadian provinces. In these the relief sought by complaining property owners was injunction against further operation of the plants. The attitude of the courts is indicated by the decisions reviewed below:

In Carpenter vs. Cummings, 2 Philadelphia Reports, 74, the Philadelphia Court of Common Pleas held that use of a steam boiler properly constructed will not be restrained as constituting a nuisance, although operated in a densely populated part of a large city. There must be actual danger, the court holds; mere apprehension of danger from improper use is insufficient. In this case an injunction was denied because the proof showed that the boiler in question was constructed of proper materials in a secure manner and was capable of withstanding the pressure to which it was subjected. The court said: "This case presents nothing more than the apprehension of the complainants that by the improper use of the boiler they or their property may be endangered. It is true that an injunction may be applied to prevent the commission of acts from which danger may be apprehended, but such

danger must be clearly shown to be a natural and inevitable consequence of the acts about to be done."

But a Canadian court has held that operation of a high-pressure boiler will be restrained when it appears that it is old and unsafe, considering the pressure to which it is subjected. (2 Prince Edward Island Reports, 226.)

The Maryland Court of Appeals declared to be void an ordinance of the City of Baltimore that purported to empower the mayor to order removal of a boiler at his will. Following the same line of reason as that adopted by the Pennsylvania court, the Court of Appeals said that a stationary steam engine is not in itself a nuisance, even if erected in the midst of a populous city, unless it interferes with the safety or convenience of the public. A boiler, holds the court, is not made a nuisance by reason of its liability, in common with other boilers, to explode, or because it is used in a business in which combustible materials are used and thereby increases the fire risk on adjoining property and proportionally enhances insurance premiums. (Mayor of Baltimore vs. Redecke, 49 Maryland Reports, 227.)

Noise in the operation of machinery may constitute a nuisance which will be abated by injunction if it is unreasonably and unnecessarily caused, according to the opinion of the New Jersey Court of Chancery, announced in the case of Keilley vs. Curley, 71 Atlantic Reporter, 700. But, declares the court: "Of course, the character and volume of noise and the time and duration of its occurrence and the place where it occurs and the surroundings thereof are the determinative features."

Similar Features of Boiler and Refrigeration Systems

By Thomas G. Thurston

SYNOPSIS—Probably you have never fully realized how much the operation of a boiler resembles that of a refrigeration system. To the experienced refrigerating engineer this article is indeed interesting, and to the beginner or man quite new in the refrigerating field it is instructive.

Expansion coils are in many respects like a boiler; the direct-expansion coils and the ordinary brine tank correspond to a water-tube boiler. The ammonia inside the coils corresponds to the water in the boiler, and the brine or air surrounding the outside of the coils corresponds to the furnace gases. The tubular-type brine cooler is much like the tubular boiler. By inclosing the ends of the ordinary tubular boiler and circulating brine instead of the furnace gases through the tubes and filling it with liquid ammonia instead of water, one would have a good brine cooler.

To get maximum capacity and efficiency from the steam boiler it must be free from soot and ash on the outside and scale and mud on the inside. The frost and ice on the outside of a coil correspond to the soot and ash on the heating surface of the boiler; the oil on the inside of the coil corresponds to the scale on the inside of the boiler. To get maximum efficiency and capacity from the coils the frost should be kept from the outside and the oil from the inside.

To get maximum capacity from the steam boiler the entire heating surface should be in contact with water. Neglecting the danger from overheating the iron, if only half of the heating surface was covered with water the capacity would be reduced by about half. The same holds good for the expansion coil. For this reason it is important that the feed to each coil be so adjusted that the whole length of the coil is in contact with liquid ammonia, otherwise only part of the coil surface will be utilized and the capacity will correspondingly fall.

Following out the boiler comparison, a number of coils on the same system correspond to a battery of boilers working together. The liquid line leading to the coils corresponds to the feed-water line to the boilers, the expansion valves correspond to the feed-regulating valves on the boilers, the stop valve on each boiler corresponds to the suction stop valve on each coil, and the suction header and suction line correspond to the steam header from the boilers.

Many are of the impression that the liquid ammonia flashes into a gas the moment it passes the valve. This is far from being true. The expansion valve is no more than a regulating valve capable of fine adjustment. If large quantities were handled the ordinary valve would do just as well. If the ammonia comes to the expansion valve at a temperature the same as, or lower than, that of the ammonia in the coil, it will pass the valve and go into the coil in a steady stream of liquid in the same manner as the feed water passes the regulating valve into the boiler. If the temperature of the liquid ammonia on the high-pressure side of the expansion valve is higher than that in the coil, as it most generally is, some of the liquid will flash into gas the moment it passes the expansion valve into the volume at the reduced pressure. The evaporation of some of the liquid into gas cools the remainder to the temperature of the rest of the liquid already in the expansion coil. To illustrate this action go back to the boiler again. Suppose the boiler pressure is zero gage, or atmospheric; the temperature of the water in the boiler would be 212 deg. Suppose the water was supplied to the boiler at 66 lb. gage and at a temperature corresponding to the boiling point for this pressure, which would be 312 deg. If the pressure is reduced on the water at the boiling point, its temperature will drop to correspond to the reduced pressure, and to accomplish this some of the water will flash into steam. When the water passes the feed-regulating valve the pressure will drop from 66 lb. to zero and some of the water will instantly flash into steam, cooling the rest to 212, or reducing its temperature 100 deg., or to that of the water in the boiler. The same action occurs when liquid ammonia passes the expansion valve, as the liquid is nearly always at a higher temperature when it comes to the expansion valve than that corresponding to the pressure in the coils. In some cases where the liquid is precooled, it may be near this tempera-

ture, which increases the capacity of the expansion coils that much more, as no volume is then required in cooling the liquid to the boiling temperature.

Evaporation Different in Different Coils

Where boilers in a battery are working together and supplied by one feed pump, one knows he cannot properly regulate the feed to each boiler by giving each feed valve the same opening. Some valves are run wide open or nearly so and others not so much. Some of the boilers may be of a larger size than others and some may have hotter fires under them than others. The result is that each does not evaporate the same amount of water, and the feed valves must be adjusted accordingly. If the water is supplied to the end of a long header running along the front or back of the boilers with a branch to each, the valves at the opposite end of the header from that to which the feed line is connected will feed fastest for a given opening. The same principles hold good with expansion coils where a number of them are operated on the same system.

In direct-expansion work each coil corresponds to a boiler in a battery. The rooms correspond to the furnaces and the air in the rooms to the furnace gases. Where two or more coils are in the same room it corresponds to two or more boilers over the same furnace. If one boiler has an extremely high furnace temperature, another a medium temperature and another a light fire in it, there will be a difference in the amount of water evaporated by each, and of course there will be a difference in the adjustment of the feed valves. The same is true of the expansion coils. The hot rooms correspond to the hot furnace, the medium-temperature rooms to the medium-temperature furnace and the cold rooms to the furnace with a light fire in it. The coils in the high-temperature rooms will evaporate liquid more rapidly than those in the medium or low-temperature rooms, and the expansion valves must be adjusted accordingly.

If one is running a boiler with a white-hot fire which gradually dies down, the feed valve must be partly closed or the boiler will fill with water which will be carried over into the steam header. The same effect takes place in an expansion coil. If the valves are set so that the coils get the correct amount of gas and liquid for a certain temperature, then when the temperature drops, as it does in many kinds of service, the coils will flood and the liquid will pass over into the suction line and be carried back to the compressor. For this reason the valve openings must be reduced as the temperature drops in the different rooms.

Effect of Pressure on the Boiling Point

One point that is not as apparent in boiler practice as in refrigeration is the effect of the pressure on the boiling point and consequently on the temperature of the evaporating liquid. In the boiler there is considerable difference between the furnace temperature and the water in the boiler—2000 deg. or more. Consequently, variation in the boiling point due to a variation of the pressure has no appreciable effect on the temperature difference between the water and the furnace. If the pressure is varied from atmosphere to 66 lb., there would be a variation of the boiling point of 100 deg. Assuming that there was a difference of 2000 deg. between the water in the boiler and the furnace at atmosphere, there would be a variation of only 5 per cent. in the temperature difference at the higher pressure. The pressure variation while a boiler is in operation is never anywhere near this, consequently its effect on the rate of evaporation is not noticeable.

In refrigeration practice conditions are not the same. Here the temperature difference is never much over 10 to 25 deg. between the room or brine and the evaporating ammonia. Under the average suction pressures a variation of one pound in the suction pressure varies the boiling point approximately from one-half to one degree. A variation from atmospheric pressure to 15.67 lb. gage varies the boiling point 28½ deg., or from 28½ below zero to zero. A variation from 15.67 lb. to 30.18 lb., or about 15 lb., varies the boiling point 17 deg., or from zero to 17 deg. On account of the small temperature difference, a difference of a few degrees in the boiling point makes considerable difference in the rate of evaporation. Suppose the brine temperature to be 15 deg. and the back-pressure 15.67 lb. The boiling point of the ammonia will be zero degrees and the temperature difference between the brine and the ammonia 15 deg. If the back-pressure is raised to 28.24 lb. the boiling will go up to 15 deg., the temperature difference will be zero, no ammonia will be evaporated and the refrigerating effect, or work done, will be zero.

This is important to bear in mind in adjusting the feed to the expansion coils in direct-expansion work where one machine is working on rooms of different temperatures. Suppose one machine to be working on rooms at a temperature of 35 deg. and on others at 15 deg.; the back-pressure is about 20 lb., which corresponds to a boiling point of 5 deg. for the ammonia. The temperature difference in the 15-deg. rooms will be 10 deg. and in the 35-deg. rooms 30 deg. Suppose the valves are so adjusted that all the coils are working at maximum capacity. Assume that the temperature of the 35-deg. rooms rises to 40 deg. This increases the temperature difference and the evaporating capacity of the coils in these rooms, and to get the temperature down again and work the coils to maximum capacity the expansion valves must be opened a little more. This increases the amount of ammonia evaporated and consequently raises the back-pressure. Raising the back-pressure raises the boiling point in the whole system, and the temperature difference and consequently the evaporating capacity of the coils in the 15-deg. rooms is reduced, and to keep these coils from getting flooded and running over into the suction line the openings of the expansion valves must be reduced. If the room temperatures change in the reverse direction the adjustment of the valves must be changed accordingly.

Rise of Voltage On Switching Off Induction Motors—It has been noticed that the stator windings of induction motors frequently break down if the rotor circuit is opened before the main switch is operated. It is thus safer to switch off at the main switch on full load than to attempt to take off the load first by opening the rotor circuit at the starting resistance. If the rotor be short-circuited when switching the stator off, the energy stored in the magnetic field will be dissipated more slowly owing to the currents induced in the rotor acting so as to maintain the field, and therefore smaller voltages will be induced in the stator winding.—Science Abstracts.

Vapor Condensers in Suction Pipes of heating-system vacuum pumps are advisable to condense steam returning along with the water. Such vapor should be condensed and the temperature of the return water lowered in order to give a satisfactory pump operation. This is often accomplished by passing the cold-water supply to the hot-water service tanks through the coils of the vapor condensers.

Constructing Foundations for Electrical Machinery

By Norman G. Meade

Foundations for machinery have two functions—to keep the latter level, with all parts in alignment, and to absorb shock and vibration. The prevention of vibration is mainly dependent on the weight of the foundation. Individual motors, motor-driven machines, such as pumps, fans, etc., motor-generator sets and booster outfits require various kinds of foundations, the selection being governed by the weight and speed of the machines. The construction of the building in which the machinery is installed also has much to do with the method of support. For a given horsepower the support or foundation for a motor depends a great deal on the speed, and if belted, on the pull on the belt and the belt angle. Motors mounted on columns or walls are liable to cause trouble from vibration, and where possible it is best to mount them on the floor.

Where vibration is not objectionable, small machines may be mounted on a timber frame bolted to the floor.

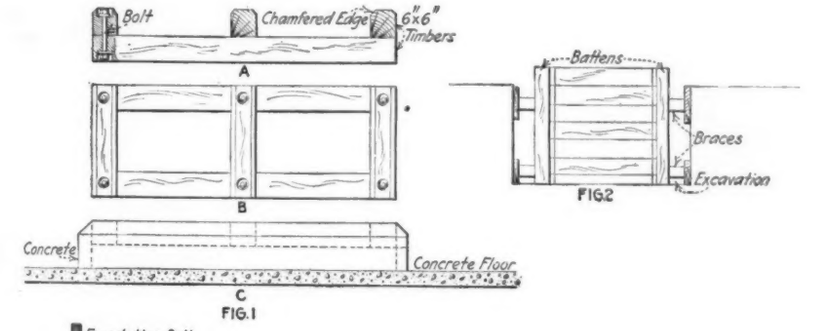


FIG. 1

FIG. 2

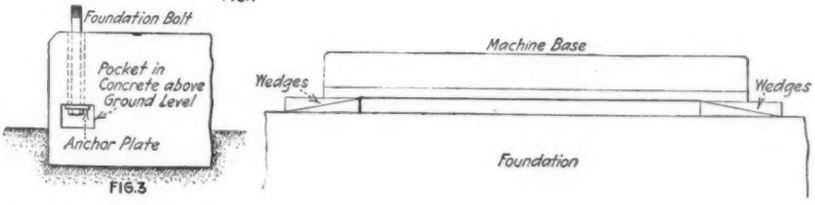


FIG. 3

It is ordinary building practice for stores, factories and warehouses, to design the floors to sustain a weight, in addition to the weight of the floor, of about 150 lb. per sq.ft. Where the floors are constructed of wood and vibration is objectionable, small motors, say, up to 10 hp., may be mounted on a spring base, consisting of two timber frames approximately the size of the motor base, separated by helical springs at the four corners. The lower frame is bolted to the floor and the motor base is fastened to the upper frame by coach screws. The safe carrying capacity of a helical spring may be determined from the following formula:

$$W = 11{,}781 \frac{d^3}{R};$$

where

W = safe carrying capacity in pounds;
d = diameter of rod material for spring in inches;
R = mean radius of coil (D-d, where D is the outside diameter of the coil).

Assume a spring where $d = 0.5$ in. and $R = 2$ in.; then $W = 11{,}781 \frac{0.5^3}{2} = 736$ lb. Four springs of like dimensions will support a weight of $736 \times 4 = 2944$ lb.

Obviously the other factor of the formula can be found by transposition.

For mounting machinery on concrete floors a good foundation is made as shown in Fig. 1. A wooden framework of 6x6-in. timbers bolted together is secured to the floor by bolts and is filled and surrounded with concrete. The height of the concrete should equal that of the framework.

On first floors of buildings where the distance to the earth is small, regulation concrete foundations are advisable. Concrete is comparatively inexpensive, is lasting and will support from 4 to 15 tons per sq.ft. The stones used in the concrete should not exceed 2 in. in any direction, and the particles should not be too uniform, as the smaller pieces fill up between the larger ones and the sand and cement fill the voids.

Excavations should extend below the frost line and should be filled in for about 6 in. with well-tamped sand if the location is dry, but if surface water is likely to percolate into the excavation a layer of gravel about a foot thick should form a base for the concrete. A form for a concrete foundation is shown in Fig. 2. It consists of wooden planking attached to battens which are braced against the sides of the excavation.

Good proportions for concrete using portland cement are: Cement, 1 part; coarse sand, 2 parts; broken stone, 5 parts. The ingredients should be thoroughly mixed dry, and after mixing add just as little water as will completely wet the material. Concrete should be placed carefully. It should be thoroughly rammed in from 6- to 9-in. layers, and after setting, the top of each layer should be cleaned, wet and roughened before placing another layer. The weight of good concrete per cubic foot dry is from 130 to 160 lb. If the earth is firm and dry in the excavation, the wood forms may be omitted, as filling out the inequalities makes the foundation much firmer.

There are numerous ways of placing foundation bolts, but it is always well to have an open space around them so that they may be sprung somewhat to enter the holes in the machine base. A good way to accomplish this is to place the bolt in an iron pipe about twice as large in inside diameter as the outside diameter of the bolt.

Foundation bolts should be in concrete foundations to a depth of at least fifty diameters. The diameter of the bolt should be the diameter of the hole in the bedplate less about one-sixteenth of an inch. Where foundations are deep enough, it is well to locate the anchor plate and nut in a pocket in the concrete above the ground level, as shown in Fig. 3. This permits removal of the bolt if necessary.

After the foundation is completed and set, the machine should be placed in position over the foundation bolts and carefully leveled by means of two wedges placed together on at least each of the four corners as shown in Fig. 4. Leveling is accomplished by hitting the upper wedges with a sledge. When level, the space between the under side of the base-plate and the foundation should be well grouted.

Visits of Inspector Brown--VI

By J. E. Terman

SYNOPSIS—Brown finds in one plant three boilers which are bagged at the same place. The Chief tells why the plates are bagged and shows that it is not necessary to cut out the distorted part and replace with a patch.

"Chief," said Brown as he seated himself at the opposite side of the table, "I want some advice on boiler repairs. I inspected some boilers today that were bagged, and in talking over what I found with the other men, their statements don't seem right, but I am not able to explain to them why I think so. The three two-flue boilers at the White Pine sawmill were bagged.

"I asked Inspector Jones about the matter first, because he was the most experienced man on the force. He wanted a full explanation as to the size of the bags, the thickness of the sheet at the bottom of the bags and other information. After I had answered his questions he stated that he thought that they should be cut out and patched, but that I should put it up to you because you were opposed to the cutting out of bags, on general principles. Jones said that if the bags were as described, the shell had been seriously weakened by the thinning down of the metal, and that unless they were cut out there would be a weak spot left in the sheet. There seems to be something the matter with Jones' argument, and especially so since he says that you were opposed to cutting out bags."

"Well," replied the Chief, "suppose you tell me as to the condition of these bags and then I will know whether I want to agree with you or Jones."

"They are all alike," replied Brown; "the boilers are each 42-in. diameter and the plate is $\frac{5}{16}$ in. thick. The bags are over the bridgewall where the hottest flames hit the shell. The distorted portion of the sheet is of about 12-in. diameter and bagged down about 3½ in. I do not know how thick the metal was at the bottom of the bags, but I should say, from the way it felt under the hammer, that it was at least $\frac{3}{16}$ in. at the thinnest point."

"What is the shape of the bags?" asked the Chief.

"Well, a side view of them would look about like this," answered Brown, making a sketch as shown.

"I suppose that sketch is drawn about to scale," said the Chief. "As I remember those boilers, the courses are about thirty inches long and from your description of the size of the bags as indicated by your sketch, my opinion is that there is no argument at all as to the proper method for repairing such defects, for they should, without question, be driven up wherever possible. The only thing that might interfere with driving them up is the proximity of the girth seams; but according to your sketch their location is not a factor in the case. One reason that patches are to be avoided in repairing such defects is that bags, as in this case, frequently occur at a point where the shell is exposed to the most severe furnace conditions and it is difficult to locate a patch at such a position on the shell that will remain tight.

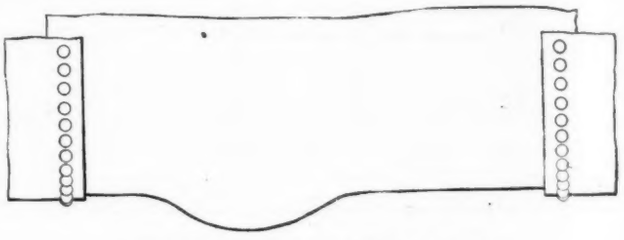
"Now, as to Jones' argument that the thinning down of the metal at the bottom of the bag would seriously weaken the shell," continued the Chief, "there is nothing in it in connection with the size of bags you have described, but it seems almost an impossibility to prevent some inspectors' reasoning in that manner.

"Take Jones, for example, an old and experienced inspector, who surely should have absorbed some correct ideas with respect to the stresses in a boiler shell by this time, but he is as bad as the raw recruit on this subject.

"You can see that a manhole could be cut in the shell of a boiler and that if the opening was supplied with a properly designed reinforcement, so that the same amount of material that was removed in cutting the opening was replaced by the reinforcement, the shell would not be seriously weakened."

"Why, yes, I can see that," said Brown, "but I don't see just what bearing that can have on the question as to whether the thinning down of the metal in a bag weakens the shell or not."

"Well," answered the Chief, "did it ever occur to you that no metal is lost from the shell plates by the formation



HOW THE BOILERS WERE BAGGED

of a bag and that all the metal that was originally in the sheet is still there after the bag has been formed and that the only difference is that the metal over the bagged section of the plate after it is driven back in place is a little differently distributed?

"The average inspector will allow a boiler maker to cut a four by six handhole anywhere in the shell of a boiler, without giving the matter a moment's thought as to whether the shell is weakened or not, but if a bag should form that would reduce the thickness of the sheet one-half, over a similar area, he would have a fit for fear that the shell would explode, even though the section of sheet surrounding the thin portion, in the case of the bag, reinforces it.

"Even when the sheet is split open at the bottom of a bag," continued the Chief, "if the opening is small enough so that a hole of not over 1¼ in. diameter will remove the portion of the sheet that is defective, the driving up of such a bag is still the proper method of repair. When a bag of this character is returned to place, it is necessary only to ream out the hole that has been cut in the sheet, which will have become considerably smaller in diameter, and close it with a rivet. Another thing to be considered is that in driving up a bag, if the work is properly done, the thinned-down section of the metal is considerably thicker after the work is completed than when it was started. Of course, it often happens that a bag will form so close to a seam in a boiler that it is impossible to drive it up without so seriously distorting the seam as to render this method of making the repairs impractical.

"There is an interesting feature about this trouble at the White Pine mill, and I wonder why you have not mentioned it; that is, all three boilers have bagged at the same place and at the same time—how do you account for that?"

"I had thought of that," replied Brown, "and had come to the conclusion that it was possibly only a coincidence. I had also thought that since all of the bags were at a point where the flames impinged most severely on the shell the forcing of the fires might have been the cause."

"It is not a coincidence," said the Chief; "boilers set over the furnace frequently all bag at the same time as these have done, and the forcing of the furnace is not a serious factor contributing toward the trouble. You know that clean boilers do not bag and that when a bag does form it is generally produced by a collection of loose scale at that point and is usually found over the bridge-wall or immediately over the fire. Bagging often occurs after a temporary period of idleness, such as starting up after the noon hour or in the morning after the fires have been banked over night.

"The reason for the collection of scale at the affected points is, that when the fire is stopped the heat from the fuel bed or that radiated from the top of the bridge-wall, as was the case of the White Pine boilers, causes an upward current of the water, which is too weak to carry up the larger pieces of scale drawn to this spot by the dying circulation in the boiler, and they are deposited in a pile. As soon as a small quantity collects, sufficient to interfere with the transmission of heat, the collection probably proceeds much more rapidly on account of the eddy produced in the current above the spot. After such a collection has formed, it only remains for the furnace to be started up again to produce a bag, for one is almost certain to form if the scale has been packed closely enough against the sheet, and you said that all the bags on those boilers were over the bridge-wall, didn't you?"

"Yes, but I had never thought before as to why they might form at that point and I can see that this is another reason why the bridge-wall should not be placed too close to the shell of the boiler."

"There is a lot more to the subject of bags," said the Chief, "and we will have a talk about bags caused by oil soon. But we will leave that subject for another day."

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Chart of Relative Values of Fuels

By Richard A. Rover

In estimating the relative steaming values of fuels of different calorific values consideration must be given to the boiler and furnace efficiencies attainable. In any instance the equivalent evaporation in pounds of water evaporated from and at 212 deg. F. per pound of coal would be,

B.t.u. per pound of fuel × per cent. of efficiency ÷ latent heat of steam at 212 deg. F.

The chart herewith has been prepared to save tedious calculations. Slanting straight lines represent the calorific value of fuel in thousands of B.t.u. per pound, each line being so drawn as to pass through points whose ordinates represent boiler and furnace efficiencies and whose abscissas represent the equivalent evaporation from and at 212 deg. F. per pound of coal.

To read the chart, start at the left-hand side at a given percentage of efficiency, as 70, and following along horizontally to the intersection with the inclined line representing the thousands of B.t.u. per pound of fuel, as 14, and then follow vertically downward to find the value 10.1 pounds of water evaporated from and at 212 deg. F. per pound of the coal, which for most practical purposes would serve the same purpose as the arithmetical solution,

$$\frac{14{,}000 \times 0.70}{970.4} = 10.098$$

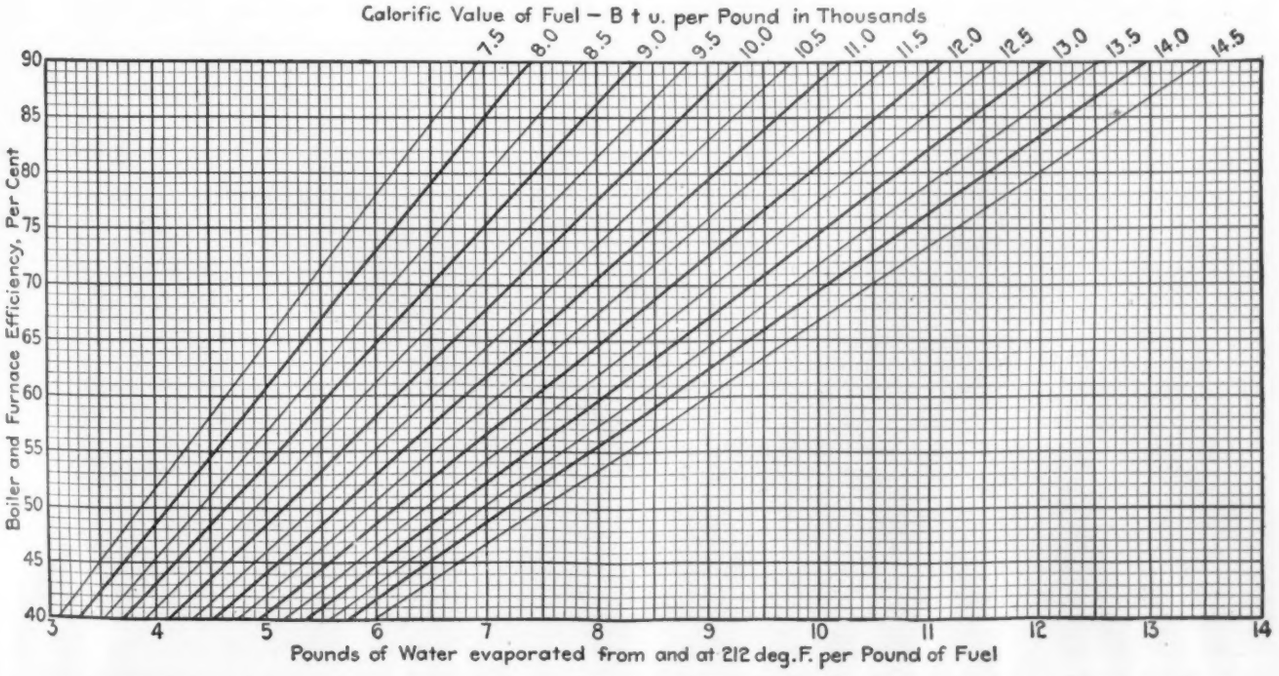

CHART SHOWING RELATION OF EFFICIENCY TO EVAPORATION FOR VARIOUS CALORIFIC VALUES OF FUEL

Sub-Bituminous Coal and Sawmill Waste in Producer Plant

By George S. Wilson*

SYNOPSIS—A series of tests conducted on a 27-hp. producer plant to determine the suitability of low-grade fuels of the Northwest, including sawmill refuse.

A considerable number of inquiries made it seem desirable to obtain data regarding the efficiency and reliability of suction gas-producer plants of small size using the low-grade fuels of the Pacific Northwest. It was recognized that tests of this kind should be made under commercial conditions so that the results obtained would be such as could be duplicated in ordinary service. Such tests were made in the producer plant in the Mechanical Engineering Laboratory of the University of Washington, about forty runs being made and seven grades of fuel used.

The producer is of the ordinary updraft type built by the Otto Gas Engine Co., with an inside diameter of 22 in. and a height of 34 in. from the grate to the top of the lining. The tar extractor is of the centrifugal motor-driven type and was operated at 1800 r.p.m.

The engine is a 11.5x19.25-in. single-cylinder, single-acting type built by the same company and rated at 27 b.hp. It has a "hit-or-miss" governor and a "make-and-break" ignition.

Method of Conducting the Tests

The producer was put in good condition and a fire started with the fuel to be tested. As soon as good gas was obtained, the engine was started. The plant was operated for three or four hours, until the fuel bed was in good condition, then it was shut down. On the following morning the ashes were removed, the fire poked and the blower started. As soon as good gas appeared the engine was started; enough fuel was added to bring the fuel bed up to the determined thickness and the load was put on the engine. The test was then started and continued for 8 hr., during which time the fuel was fired in regular quantities and at regular intervals, the fire being worked sufficiently to keep it in good condition. Just before the close of the test the fuel bed was poked and enough fuel added to bring it to the starting level.

Water for the vaporizer was taken from a calibrated tank and the water for the centrifugal scrubber was measured by a small meter. The power used by the motor-driven centrifugal scrubber was determined by a wattmeter. Temperatures of the gas were taken at the outlet pipe of the producer and near the engine. Indicator diagrams were taken at regular intervals and the load was absorbed by a prony brake. Revolutions and explosions per minute were obtained by continuous counters.

Small samples of coal were collected from each quantity as fired, the whole quantity obtained for any particular fuel being quartered and an approximate analysis and heat-value determination made. A pipe was connected to the main gas line, near the pressure-regulating tank, and a small rotary blower was used to draw the gas from the line and deliver it, under a small pressure, to a Junker's calorimeter. The value given is the higher heat value at 62 deg. F. and atmospheric pressure.

No attempt was made to get an analysis at regular intervals. At irregular times samples were taken and a complete analysis made. At more frequent intervals a sample was taken and tested for CO, O and CO_2. The gas was fairly uniform and an average analysis when using coal showed carbon-dioxide 2.8 per cent., carbon-monoxide 24.1 per cent., methane 3.6 per cent., hydrogen 12 per cent. and nitrogen 54.9 per cent.

Different Fuels Used on the Test

Sample No. 1 is a wood charcoal obtained from a small experimental wood-distillation plant. It gave a satisfactory gas and did not require the use of the centrifugal scrubber. The test was made to indicate what might be expected from this particular plant.

Sample No. 2 is a grayish-brown washed pea coal and is classed as sub-bituminous. It gave a fairly uniform

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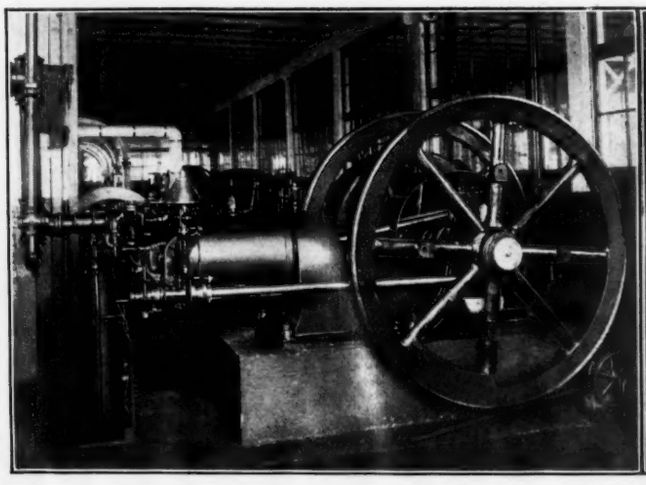


FIG. 1. ENGINE USED ON TEST

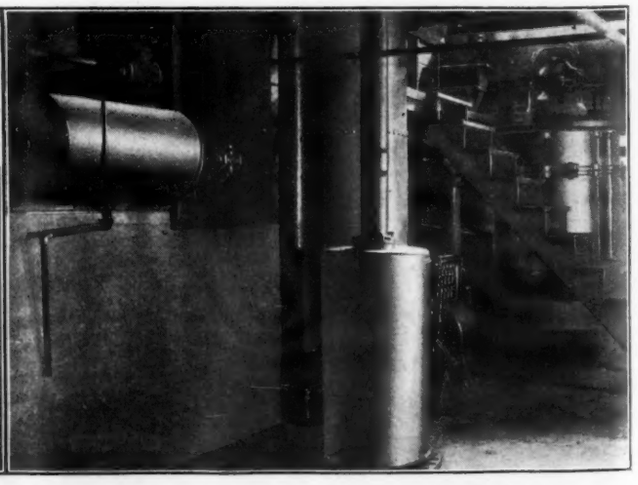


FIG. 2. PRODUCER ROOM AT LABORATORY

quality of gas, but was inclined to clinker, and it required considerable attention to keep the fuel bed in good condition.

No. 3 is classed as a bituminous coal, is nearly pitch black and contains a large amount of ash. The sample furnished was run-of-mine, broken to pass through a 1½-in. screen, and it was fired without any attempt to ob-

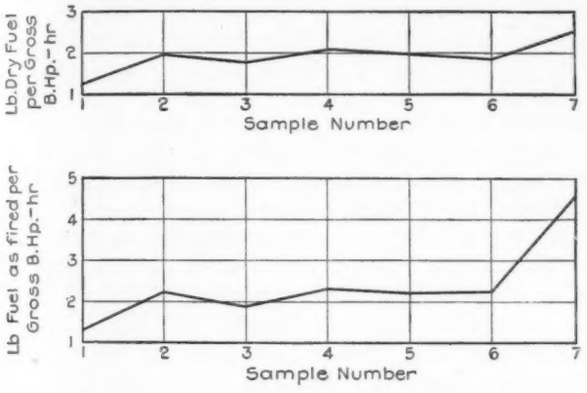


FIG. 3. FUEL PER HORSEPOWER-HOUR

tain a uniform size. The fuel bed was found to be somewhat sensitive, owing no doubt to the uneven size of the coal.

Sample No. 4 is a washed pea coal and is classed as high-grade sub-bituminous. When freshly fractured it is a pitch black, but turns to a grayish black in a short time. This coal gave good results and caused very little trouble from clinkering.

No. 5 is a washed pea coal and is classed as high-grade sub-bituminous. It gave a fairly uniform gas, but it required considerable attention to keep the fuel bed free from clinkers.

No. 6 is a washed pea coal and is classed as low-grade sub-bituminous. It is grayish black and contains a large amount of water. A small amount of clinkering occurred, but the fuel is fairly satisfactory.

Sample No. 7 is sawmill refuse. The bark and wood of hemlock and fir were passed through a hogging machine until a coarse sawdust was obtained. The fuel was fed to the producer in this form and gave very satisfactory results. The gas was of uniform quality, and the fuel bed required no poking. Some trouble was experienced with this fuel, due primarily to the type of producer. At the end of seven or eight hours enough of the fine fuel would have found its way into the gas outlet to restrict the opening. This partial closing of the outlet increased the draft, and the opening would fill very rapidly from this time on. Consequently, when the suction near the producer commenced to increase quite rapidly, we called the test finished and the plant was shut down. The gas outlet was cleaned, requiring from one-half to one hour's time, and the plant was ready to start the next morning. With a gas outlet arranged especially for this kind of fuel this trouble could be eliminated.

Results of the Various Tests

Figs. 3 and 4 show respectively the fuel consumption and efficiency of the plant. The overall efficiency is much better than can be obtained in a steam plant of this size, and with an operator that understands his business the cost of attendance will not be any greater.

In using the sub-bituminous coal some extra work was caused by clinkering. In order to get real satisfactory conditions for coals similar to samples 2, 5 and 6, the steam supply to the producer would have to be increased. This was not possible in the present case, because as soon as the steam supply was increased beyond a certain limit, the engine, due to preignitions, would pound heavily. With an engine of lower compression this could have been avoided and the increased steam would have aided in reducing the clinkers. Other coals, similar to samples 3 and 4, can be used satisfactorily with an equipment similar to the one under test.

The tests on the mill waste are of interest on account of the cheapness and ease of obtaining this fuel in the Northwest. These runs seem to indicate that, with a producer having proper gas outlets and fitted with a mechanical feeding device, good results could be expected.

In using fuels like the ones tested considerable tar is taken out at the tar extractor. Careful attention is required at this point. Very little tar was carried to the engine and the only trouble experienced was a slight sticking of the gas-intake valve. It was necessary to clean this valve about every three weeks.

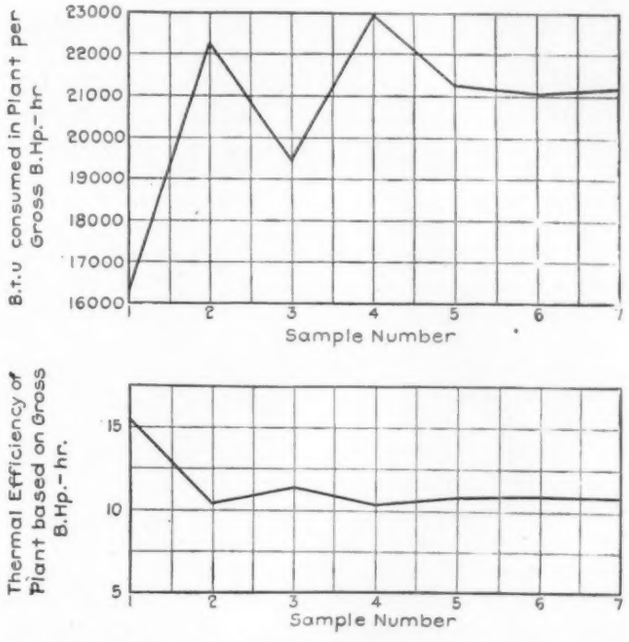


FIG. 4. HEAT CONSUMPTION AND THERMAL EFFICIENCY

SUMMARY OF THE TESTS

Sample number.	1	2	3	4	5	6	7
Moisture, per cent.	3.0	12.65	5.50	9.84	13.00	18.86	44.8
Ash, per cent.	....	11.27	19.20	14.44	16.90	10.40	....
Volatile matter, per cent.	....	35.70	34.13	38.62	33.10	34.08	....
Fixed carbon per cent.	....	40.38	41.17	37.10	37.00	36.66	....
B.t.u. per lb. dry fuel.	12,990	11,476	10,924	11,005	11,003	11,461	8,419
B.t.u. per cu.ft. gas.	136	172	171	180	172	176	130
Number of tests	1	7	7	6	6	6	6
Indicated horsepower.	30.6	33.2	34.0	35.4	33.5	33.2	20.3
Gross brake hp.	22.7	23.4	23.7	23.8	24.1	24.3	19.7
Fuel consumption as fired:							
Lb. per i.hp.-hr.	0.96	1.57	1.31	1.52	1.59	1.66	3.14
Lb. per gross b.hp.-hr.	1.29	2.22	1.89	2.31	2.22	2.27	4.57
Lb. per net b.hp.-hr.	1.29	2.58	2.16	2.62	2.51	2.57	5.24
Dry fuel:							
Lb. per i.hp.-hr.	0.93	1.37	1.24	1.38	1.39	1.34	1.73
Lb. per gross b. hp.-hr.	1.25	1.95	1.79	2.09	1.93	1.85	2.52
Lb. per net b. hp.-hr.	1.25	2.25	2.05	2.38	2.18	2.09	2.91

The Panama-Pacific Exposition--VII

By F. R. Low

SYNOPSIS—Metering, indicating and recording apparatus. The display of power-plant instruments at the Exposition, while far from complete, contains many interesting examples which are briefly described.

Although, as I have already pointed out, the makers of instruments of precision, such as indicators, gages and CO_2 recorders, have not made even their customary showing, there is still much to see in this line, and an instructive hour can be passed in any one of a half-dozen or eight exhibits. Photographs of some of these are herewith reproduced.

Exhibits of the Bristol Co.

In 1889 Prof. William H. Bristol, of Stevens Institute, commenced the manufacture in his barn of a belt fastener upon which he had taken out a patent and of a pressure-recording gage. By 1914 the floor space required had increased from the 144 sq.ft. of the barn to the 123,306 sq.ft. of the Waterbury factory, and the line to include indicating and recording instruments for all sorts of purposes. Ordinary pressures are measured by the movement of a Bourdon tube having a number of coils wound helically and giving sufficient deflection to be indicated by a needle attached directly to its end. More delicate pressures are measured by compound diaphragms, as in the aneroid barometer, the diaphragms being held together upon the side by a rigid fastening strip, so that a light pressure produces an exaggerated tipping movement, which again is indicated by a needle carried directly by the diaphragm. Many applications of these principles are shown: A tachometer, for instance, which indicates the speed of a rotating shaft by measuring the vacuum created in a tube carried across it, by throwing the air out of it by centrifugal force; a delicate gage for measuring blood pressure; a gage indicating upon a gage at the booth, the height of the tide in the bay by the water pressure in a submerged receptacle; and gages recording small differential pressures.

Temperatures and electrical indications, as well as pressures, are recorded. In fact, anything that can be indicated or measured, Professor Bristol will make a recording gage for. Electrically, there are recording voltmeters, ammeters and wattmeters for both alternating and direct current, also cycle and power-factor recorders of both strip and circular-chart type. The most interesting demonstration in the exhibit is that of the long-distance transmitting, receiving and recording of temperatures, pressures, liquid levels and motions, as of a valve stem, or anything in fact that can be indicated on a gage. The principle is that of the induction balance, and the instruments are independent of temperature variation or voltage changes, the pointers upon the transmitting and receiving gages traveling exactly alike, although connecting only through a wire of up to 40 mi. in length. There is also shown the Bristol-Durand radii-averaging instrument for integrating circular chart records. The original belt fastener is still made in large quantities, but shares the demand with three other types of metal fasteners, plates, hooks and wire lacings. The advantages of the Bristol safety setscrew and capscrew with fillister head are demonstrated by separable wrenches which expand over and slip around a square or hexagonal nut when pressure is applied, while the fluted Bristol wrench hangs onto and turns its fluted screw, with no tendency to expand or slip.

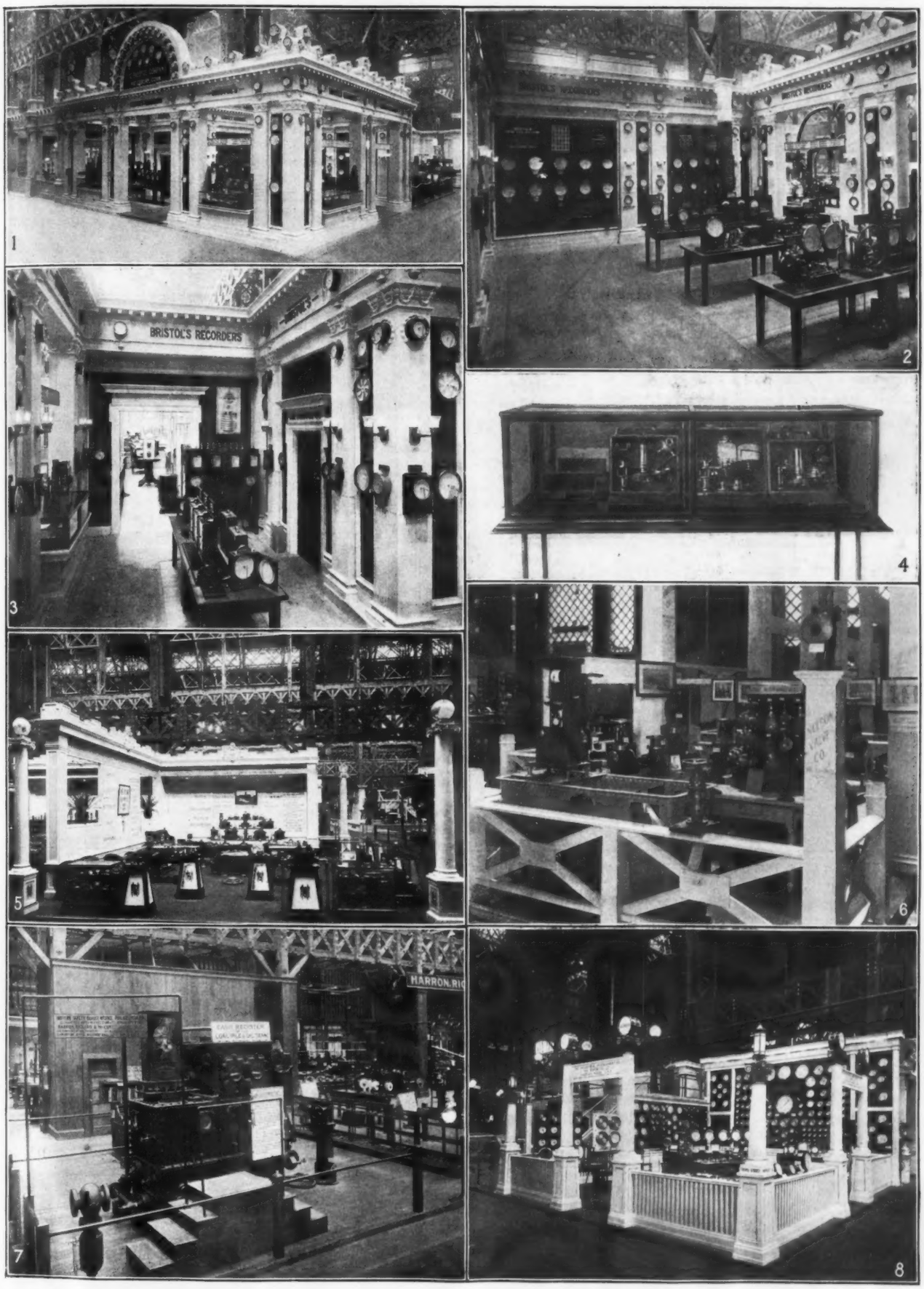
Electric time recorders record the time that certain machines are stopped and started, cars pass, boilers are fired, engines cut in, etc. One is exhibited with six pens having a limited motion upon one chart; they are made up to 20 pens. By means of a temperature-control device, air and gas valves or electrical resistances are operated so as to maintain temperatures at a desired point. The inexpensive base-metal couple is used for the measurement of intermittent temperatures up to 2,500 deg. and continuous temperatures up to 1,200 deg., and for higher temperatures the platinum-rhodium thermocouple is employed.

The Exhibit of the Foxboro Co.

Benjamin H. Bristol, father of Prof. William H. Bristol, of the Bristol Co., and E. H. and B. D., his two other sons, are associated in the Foxboro Co., until recently the Industrial Instrument Co., of Foxboro, Mass. They were formerly connected with the Waterbury enterprise, and their products are along the same general line, except that they have acquired the Standard Gage Co., of Syracuse, N. Y., and continue its line of simple Bourdon tubes, pressure and vacuum gages. For the recording gages they too use the helically twisted Bourdon tube, but attach the index to a shaft pivoted in the axis of the helix and attached to the free end of the compound Bourdon by means of a metal strip flexible only in the direction of the radial expansion of the tube. They also use the compound diaphragm, although the restraining member upon one side of the bellows-like arrangement is not an inflexible strip, but two coiled springs soldered to the edge of a diaphragm at each convolution. They make indicating and recording instruments for any pressure from full vacuum to 20,000 lb. per sq.in., differential gages to record as low as $^1/_{200}$ of an inch of water, temperature-measuring instruments from 60 to 3,000 deg. F., and the Dr. Horn system of tachometers, or direct-reading speed-measuring instruments, both indicating and recording types; all sorts of temperature-control orifice meters for measuring the flow of air and other gases, and a differential gage that may be used in connection with pitot and venturi tubes.

Trill Indicator Co.'s Exhibit

I have already written that only one indicator maker is represented at the exposition. In the exhibit of the Bessemer Gas Engine Co. is the case (the photograph of which is here reproduced) containing a number of instruments made by the Trill Indicator Co., of Corry, Penn. There is a continuous-diagram instrument with outside spring, and of the ordinary type, one with outside and one with inside spring. All have reducing wheels. The case contains also a planimeter of the sliding-wheel type.



1, 2, 3. THE BRISTOL CO. 4. THE ONLY INDICATOR EXHIBIT. 5. THE NATIONAL METER CO. 6. THE LEA V-NOTCH METER. 7. THE COCHRANE METERING HEATER. 8. THE FOXBORO CO.

Probably the most comprehensive exhibition of water meters that has ever been brought together is that of the National Meter Co., which shows a line of meters of various types from ⅜ in. to 30 in. Each of a number of cases shows the progressive steps in the manufacture of a different type of meter from the ingot metal to the finished product. On stands adjacent to these cases the respective meters are shown in operation, with glass sides through which the movement of the parts can be readily seen. There are also models, which may be handled, of the different types of displacement chambers.

There are to each type of meter three principal parts—the displacement chamber, the intermediate gear train, and the recorder, or indicating mechanism. The movement of the member that produces the displacement must be carried through the intermediate gear train to the recording mechanism, and this involves the use of some kind of a stuffing-box and packed shaft. The intermediate train is very neatly gotten rid of in the "Magno-Seal Crown," which is completely shut off from the wet side of the meter and rotated by a magnet on the moving member of the displacement portion.

Most of these meters are made to be used with hot water as well as cold, and measure oil and other liquids as well as water. For measuring larger quantities of water the "Premier" meter is used. This is a double venturi consisting of a larger venturi and a smaller one connected between its upstream and its throat and calibrated to pass one-hundredth of the capacity of the larger tube. An "Empire" meter is placed in the smaller venturi, and the total flow is indicated by proportion. This is made up to 60 in. in diameter.

There is also a meter which will measure with equal precision a flow of 75 gal. per min., or of 2 gal. per min. by the automatic cutting in of a meter of smaller capacity when the flow becomes too small to be accurately measured by the main meter.

In a case are shown the first disk meter ever built, a "Gem" meter which has been in service for 41 yr.; a "Crown" meter, for 34 yr.; and an "Empire" meter, which has passed an amount of water which would serve an ordinary family for 250 yr. and is still in perfect operative condition. Apparatus for calibrating meters is also shown.

Miscellaneous Measuring Instruments

There is the Cochrane metering heater, with a Cochrane recorder for its connected V-notch meter; a Lea V-notch meter by Yarnall & Waring in one of the collective exhibits, and the venturi meters in the Pelton Waterwheel Co.'s exhibit; also a Hoppes metering heater designed for use with the Badenhauser boiler, but still in its case. The Hohmann & Maurer division of the Taylor Instrument Co. has some cases of high-grade thermometers and recording instruments in the exhibit of Berger & Carter Co. The General Electric Co., while it has no exhibit of them as such, has a number of its flow meters in operation, and the Bacharach Industrial Instrument Co. has a pressure recorder in "The Mine."

The pneumercator is a device for measuring submergence, water levels, etc., by means of the pressure due to the head. It consists of a pressure gage connected by a small tube, which may be of any length, to a submerged vessel. In the side of the vessel is a straight-edged slot, and a few strokes of an air pump, made previously to making an observation, expels any water that may be in the connecting tube above the height of this slot. The pressure of the air required to expel the water down to that level is an index of the head of the water, or of the submergence of the vessel up to that reference line. By

THE PNEUMERCATOR

THE TAYLOR INSTRUMENT CO.'S PRODUCTS

measuring the submergence of vessels before and after loading the weight of cargo added may be determined, and this is one of its principal uses. It is also used to measure the depth of oil in double bottoms. The United States Weather Bureau has one in the Whitehall Building in New York to measure the tide, and it could readily be applied to power-plant uses, such as measuring the depth of water in roof or cellar tanks.

The Junkers Dynamometer

The simplest and most widely used device for measuring the performance of prime movers is known as the prony brake. Its advantage lies in the fact that it is simple and inexpensive to construct and, as long as it is

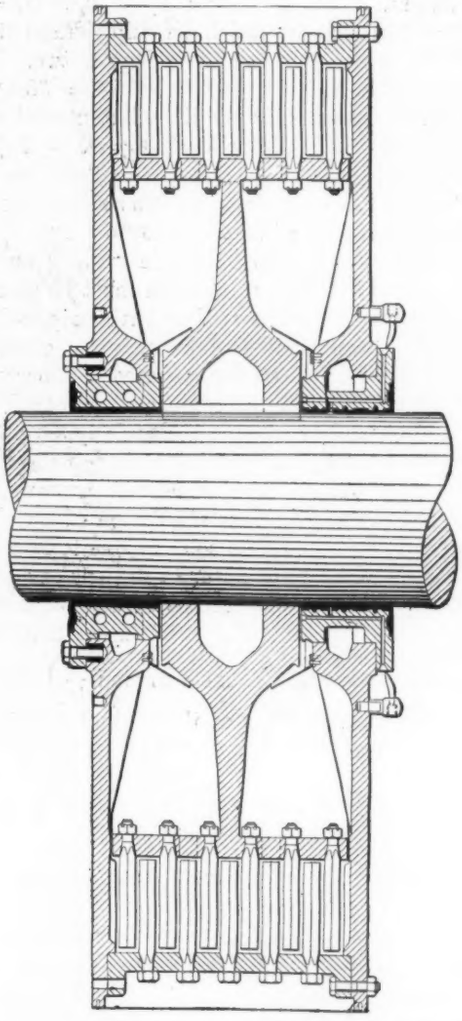


FIG. 1. SECTION THROUGH CASE OF JUNKERS DYNAMOMETER

confined to smaller outputs, permits of a fair degree of recording accuracy. Its disadvantages are that for good working conditions it requires careful construction and constant attention. It is subjected to heavy wear resulting from surface friction, and difficulty is experienced in disposing of the heat that is produced as a result of such friction, and by its use racing of the engine or motor under test often leads to the destruction of the brake. Another objection encountered with an ordinary brake for testing engines above 200 hp. is the difficulty of securing nice adjustment, owing to the necessary bulk and weight of the apparatus. The ordinary band and rope brakes, such as frequently used in testing practice, which are other applications of the same principle, are burdened with similar disadvantages.

The disadvantages of the old forms of prony brake are overcome in brakes so designed that the power is absorbed by the frictional resistance of rotating disks which are pressed together by hydraulic pressure and cooled by circulation of water, like the Alden brake; while in others, like the Froude brake, motion is imparted to water or some limpid liquid and resistance is created by obstructing the free passages of the liquid when impelled by vanes rotated within a stationary case.

The Junkers dynamometer, invented and patented by Prof. Hugo Junkers, who is also known as the inventor of the calorimeter, the oil engine and other appliances bearing his name, comes under the last-mentioned type.

Instead of employing vanes or disks, this dynamometer uses a series of square-sectioned studs or bolts, a number of which are fastened on the rotor, while the rest are fastened in the surrounding cover or casing. Fig. 1 shows a section through the case and rotor of a Junkers dynamometer, which is designed for testing marine oil engines of 1500 hp. and more, under widely varying service con-

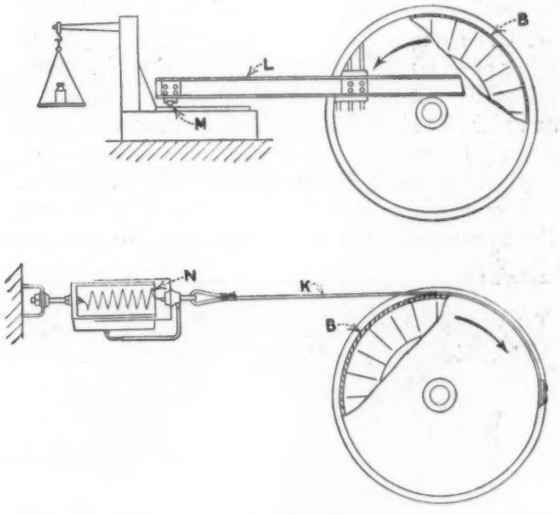


FIG. 2. METHOD OF MEASURING THE TURNING MOMENT WITH JUNKERS DYNAMOMETER

ditions. The rotor is keyed on the driving shaft, while the casing is set on bushings and permitted to swing freely on the shaft. Water is admitted into the casing above and, after serving as a medium of resistance and cooling, is discharged below. This water is whirled around and splashed by the studs of the revolving rotor and impinges on the opposing studs of the casing. As a result of the impact the casing tends to turn in the same direction as the rotor. To measure the resulting turning moment a platform scales or a spring balance may be used, as is customary in all such dynamometers as indicated in Fig. 2. Fig. 3 is an illustration of the rotor and Fig. 4 shows a complete brake, with water inlet, outlet and scale beam attached, as used to test the efficiency of a 1,000-hp. Junkers oil engine.

The Junkers dynamometer offers the advantage of being simpler and cheaper to construct than most forms of water brakes and can be used in either direction of rotation without change, which is an important factor

when testing marine and other reversible engines. The action of the brake is smooth and elastic, and by its use racing of the engine under test is quite impossible, because of the excellent heat efflux and conduction. The instrument is practically unaffected by wear of parts, and

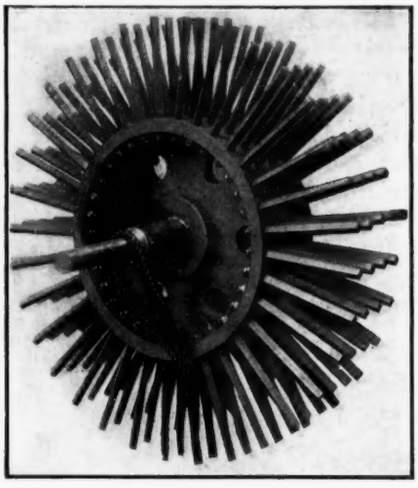


FIG. 3. ROTOR OF JUNKERS DYNAMOMETER

in operation attention is confined to observation of the effort to be weighed on the scales and to adjustment of the flow of water through the brake in case the water pressure should change or when the load is changed. There is no axial thrust on the bearings, as the water can circulate freely between the bolts. This effects a good mixture between the incoming water and the water which has been heated by internal friction. Hence the mean temperature of the dynamometer is kept low with a low consumption

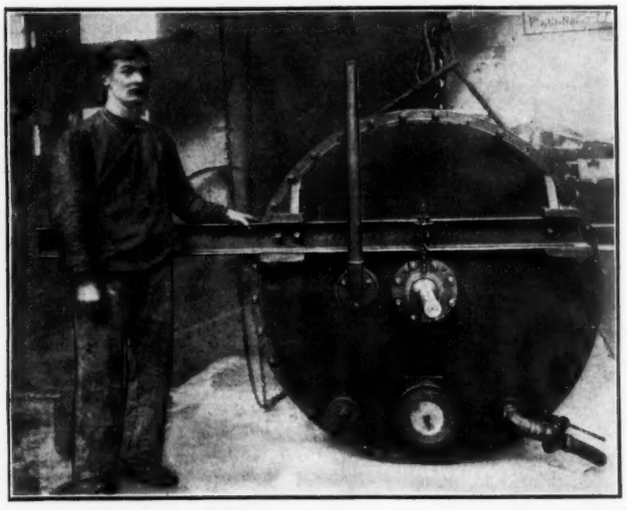


FIG. 4. JUNKERS DYNAMOMETER COMPLETE WITH SCALE BEAM

of cooling water and without danger of sudden vaporization, which are important considerations in operating dynamometers of the brake type.

Although dynamometers of the disk type may be preferable for testing high-speed engines and turbines, this type of water brake is well adapted for speeds ranging between 100 and 1000 r.p.m., especially for marine engines, which must be tested under various service conditions. The same size of brake can be used for testing engines of a variety of sizes and capacities.

What Is a Normal Solution?

By Donald M. Liddell

In references to the treatment of boiler-feed water, gas analysis and other boiler-room chemical problems, the engineer is often brought into contact with the phrase "normal solution." What is a normal solution? The definition is not reassuring: "A normal solution is one in which a liter of solution contains a quantity of the substance, expressed in grams, equal to its molecular weight, divided by its hydrogen equivalent." Fortunately, this definition is not so bad as it looks.

For instance, a normal solution of hydrochloric acid ($H + Cl = 1 + 35.4 = 36.4$ molecular weight) would contain 36.4 grams of hydrochloric acid per liter. But normal sulphuric-acid solution ($H_2 + S + O_4 = 2 + 32 + 64 = 98$ molecular weight) would contain 49 grams per liter, since its hydrogen equivalent is two. Normal sodium chloride ($Na + Cl = 23 + 35.4 = 58.4$) would contain 58.4 grams of salt per liter, but normal sodium-carbonate solution ($Na_2CO_3 \cdot 10\ H_2O = 23 \times 2 + 12 + 16 \times 3 + 10 \times 1 \times 2 + 10 \times 16 = 286$) would contain 143 grams per liter, since the two sodium atoms have a hydrogen equivalent of two.

This last compound shows that in making up normal solutions the water of crystallization must be considered. Although we usually write sodium carbonate as Na_2CO_3 in chemical equations, it is done only for convenience, and when normal solutions are prepared it is necessary to recognize that the salt as ordinarily prepared is not Na_2CO_3 of 106 molecular weight, but $Na_2CO_3 \cdot 10\ H_2O$ of 286 molecular weight.

The normal solutions are sometimes inconvenient to prepare. For instance, a normal solution of hydrochloric acid or of ammonia would be so strong as to lose HCl or NH_3 by evaporation, while normal solutions of some salts would often be impossible because saturation is reached below the normal point. For this reason tenth-normal solutions are often used $\left(\text{usually written } \frac{N}{10}\right)$ which are, one-tenth the concentration of the normal solution.

AMOUNT OF SUBSTANCE IN NORMAL SOLUTIONS

Substance	Chemical Formula	Molecular Wt.	Hydrogen Equiv.	Amount in Grams per Liter
Sodium carbonate	$Na_2CO_3 \cdot 10\ H_2O$	286.16	2	143.03
Sodium carbonate	Na_2CO_3 (fused)	106.00	2	53.00
Sodium bicarbonate	$HNaCO_3$	84.01	1	84.01
Potassium carbonate	K_2CO_3	138.20	2	69.10
Sodium chloride (salt)	$NaCl$	58.46	1	58.46
Ammonia	NH_3	17.03	1	17.03
Sulphuric acid	H_2SO_4	98.09	2	49.05
Hydrochloric acid	HCl	36.47	1	36.47
Caustic soda	$NaOH$	40.01	1	40.01
Caustic potash	KOH	56.11	1	56.11
Calcium chloride	$CaCl_2$	110.99	2	55.49
Calcium hydroxide	$Ca(OH)_2$	74.02	2	37.01

With the above explanation in mind, the calculation of normal solutions becomes an easy matter. From the formula of the substance (including water of crystallization) and the table of atomic weights in any chemistry, calculate the molecular weight of the substance, divide by its hydrogen equivalent, and the result is the number of grams of the substance which (assuming it is chemically pure) would give a normal solution when dissolved in a liter of water.

The accompanying table gives the amount required in a normal solution of a number of substances in common power-plant use. The molecular weights are calculated by the accurate values given in the International atomic-weight table, 1914.

Editorials

A New Engineering Association

Elsewhere in this issue the aims and objects of the American Association of Engineers are given. It is a new organization devoted to the uplift of the rank and file of the engineering fraternity. Out of one hundred thousand men in this country who may properly call themselves engineers, it is estimated that nearly two-thirds are not members of any well-recognized organization such as the four great national societies and other engineering associations local in their membership. These men, for the most part young men a few years out of college and older men who have not seen fit to affiliate with the older associations or who have gained their knowledge from years of practice, are working individually for a wage not commensurate with their learning and the years of preparation required. They have no recognized standing such as is enjoyed by the legal, medical and military professions, and very little of the credit for the commercial achievements resulting directly through their efforts is given them. This is partly because of the reticence of the average engineer, his concentration on the technical points of his daily labors and a conscientious adherence to the code of ethics observed against advertising or self-exploitation. When this is backed by a woeful ignorance on the part of the public relative to engineering matters, it is small wonder that the engineer is given little consideration and is paid a wage frequently below that demanded by the various trades.

To correct this injustice and to better the position of the average engineer is the object of the new association. It is not intended to elevate those that are already enjoying the rewards of their learning, but to bring up the standing of the rank and file to that attained in other professions. The help of the big engineer and the employer of engineers is solicited; in fact, their coöperation will be necessary if the association is to be brought to the highest point of usefulness.

As explained in the article already referred to, it is proposed to conduct the work of the association along five distinct channels. Means for the interchange of information will be afforded in a bulletin to be issued regularly. A service clearing house will bring employer and employee together, and the latter will have the stamp of approval of the qualification committee. Patent and legal advice will be available from the secretary's office. The association will attempt to supervise and guide along proper channels legislation pertaining to engineering. By proper publicity it is intended that members of the association will be given due credit in the bulletin for the work they have done. Popular articles in the daily press or elsewhere, written in simple language understandable to the layman, will educate the public on engineering matters and the character of work an engineer is called upon to do.

These, in brief, are the aims and objects of the association and the methods by which they are to be fulfilled. Its success will depend largely on the personnel of the officers, the enthusiasm of the membership and the coöperation they receive from the employers and engineers who have sufficient prestige to forward the movement.

Though rather ambitious, the program outlined is excellent. Without doubt there is a field for such an organization, and only a partial realization of its ideals should result in a great deal of good to the engineering fraternity. The work will be distinctive and should not interfere with that of existing engineering organizations. If present plans are followed the roster will consist largely of engineers unaffiliated with other organizations and who in time should make excellent candidates for membership in the older societies devoted largely to the consideration of technical subjects.

The new society is still in its swaddling clothes and is feeling its way. Membership is the immediate cry and must be had before any effective work con be done. The need of an association organized on the lines given is evident, and it will be of interest to watch the growth of the movement now under way.

A Report Worth Reading

Engineering reports as a rule make exceedingly dry reading and are often utterly unintelligible to the layman, being surpassed in this respect only by the average legal document. Without doubt many meritorious recommendations concerning engineering projects have been rejected solely through the inability of the sponsors to present their cases in such form as to be attractive and readily understood by the business man or financier upon whom the decision rests. It has been said that an engineer's training, which is largely of an analytical nature, is responsible for his inability to generalize and to express himself other than in technical terms. This is probably true to no greater extent than the financier measures results in dollars and cents. The fact is that too often, when we have some suggestion to offer, we do not take the trouble to first view it through the other fellow's spectacles.

A striking departure from the usual practice is to be found in the report of Morris L. Cooke, director of public works of Philadelphia. Although addressed to the mayor, it is really an account to the people of Philadelphia of the stewardship of the 4,000 employees in this department. It is written so that not only can any layman read it, but anyone having the welfare of his city at heart cannot fail to be intensely interested in the story of what is being done to improve local conditions, and at the same time effect economies. Mr. Cooke firmly believes that in order to do effective work it is necessary to gain the support and coöperation of the people by letting them know just what is being accomplished or attempted. To this end lectures have been given, exhibitions held, and even moving pictures called upon.

The economies effected by the Bureau of Water form a most interesting chapter. Here the operating expenses during the past three years have been reduced nearly half a million a year. The yearly coal consumption has been cut by about 20,000 tons, and the revenues have increased by about $240,000 a year. Excellent work appears to have been accomplished by the Bureau of Gas, and Mr. Dickerman, as head of this bureau, has made an exhaustive investigation into the electric rates existing in other large cities. By comparison with those for similar service in Philadelphia, he has shown the latter to be excessive. The results of this investigation were used as evidence in action brought by the city before the Public Service Commission of Pennsylvania for a reduction in the rates of the Philadelphia Electric Co.

Why not more reports of this kind, instead of the voluminous and meaningless type which are gotten out at great expense by many municipalities.

The Engineer's Opportunity

If conditions in small power plants generally are nearly as deplorable as would be gathered from letters received at this office occasionally, there certainly is a golden opportunity awaiting the engineers who have the combined skill and business acumen to take advantage of them. Particular reference is made to private power plants of small and medium size that are being mismanaged to the extent of making street service, at almost any price, cheaper. The responsibility for the uneconomical operation of small plants does not rest altogether with the owner in every case. He is not a trained engineer and cannot be expected to be able to see even the most glaring faults in occasionally passing through the plant, with his mind occupied perhaps with matters entirely foreign to the mechanical efficiency of the various separate units. It is the duty and function of the engineer to so analyze the situation that he may be sure of the benefits obtainable from changes in equipment by the outlay of a certain amount of money.

One of the most critical tests a proposition can be put to is whether the advocate of it is willing to put money into it himself. This is also the most convincing argument, if argument be required, that the engineer can advance in favor of an expenditure. If operating conditions are such that the engineer is convinced that a better feed-water heater, for example, will effect a saving commensurate with the expenditure, it is "up to him" to present the case in good understandable form to his employer. If then, for reasons of his own, the latter does not heed the suggestion, he will in all probability be set to thinking—and to good purpose if the engineer asserts his belief as to the soundness of the proposition as a business enterprise by offering to assume the risk or financial responsibility himself for a fair share of the profits therefrom.

This applies, of course, only to the larger operations and equipment, where the effect can be segregated and determined without difficulty. On the other hand, there can be no good reason why the operation of the entire plant cannot be negotiated on the service basis. Complaints from either side that things are not as they should be can generally be put to the dollars-and-cents test and satisfactorily settled. The present-day tendency is toward state and Federal supervision of public utilities, and in some states the cost of production must be within certain bounds or changes will be ordered to effect better economy, all of which is being accepted with reasonably good grace in the realization that any economic loss is a public loss. Why then should not the engineer be the "utility commissioner" for his plant? Who can be in a better position to see and know? Not seeing and not knowing puts him in the class of those who, having eyes, see not, and ears, hear not the things that so vitally concern his employer as well as himself. Make good or make room.

Without Benefit of Engineers

The utility of public-service commissions is unquestioned. It has been proved, however, that matters of technical engineering requiring broad specialized training and wide judgment should be handed over to a department composed of engineers having these capabilities.

For this reason it is regrettable that the New York Constitutional Convention did not heed the petition of the Committee of Engineers, that the state's engineering activities, control of state lands and buildings, and conservation projects be included in the work of a Department of Engineering and Public Works, with three commissioners in charge for a period of twelve years.

If the main purpose of the revised constitution is "the driving out of invisible rule"—the overthrowing of bossism—it has failed to do so in the matter of successful conduct of public-property management, the regulation of public-utility corporations, etc.

The proposed constitution purposes to make public-service commissioners constitutional officers, and in their twenty years' service they would be practically irremovable except "by the senate" or on the governor's recommendation. In a commission packed by henchmen of pliant corporations, the latter would be in control for twenty years and public interests would have no remedy. This constitution's makers have been criticized as framers of a "charter of privileges" for the gain of certain properties and politicians.

Politics in commissions has been the chief reason for many glaring instances of gross incompetency and neglect of high responsibilities. Under the control of a Department of Engineering and Public Works, as proposed by the engineers, there would be small opportunity for politics to figure largely in its affairs, and the work would be administered by men whose training has fitted them for their office rather than by those whose main qualification is a susceptibility to political influences.

The proposed constitution is open to grave criticisms, and many doubt if it will be ratified by the people of New York.

"Here are my necessary evils," remarked a power-plant manager to his visitors at the plant. What drivel! No engineer, no factory; and no factory, exit the manager. There are fool folks who will contend that labor itself is an evil. They should fix the blame where it properly belongs—away back in the Garden of Eden.

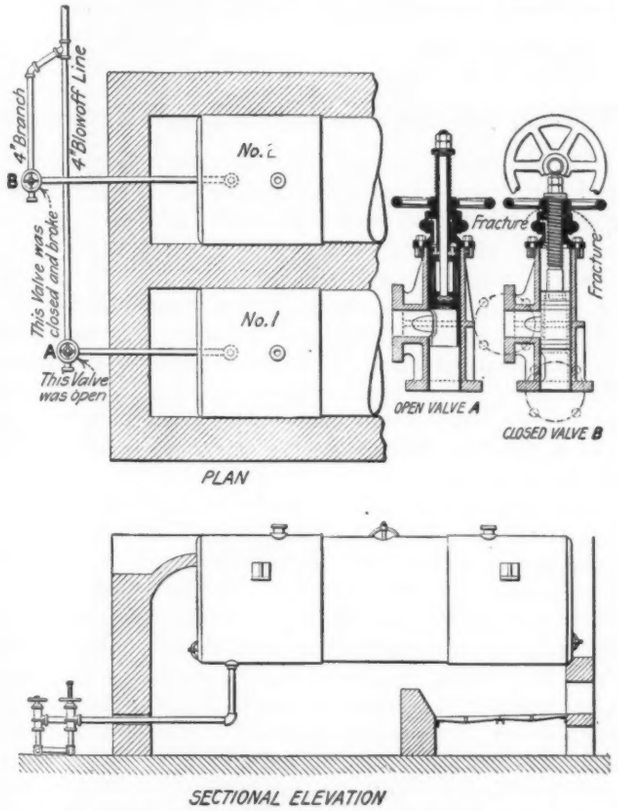
The engineer who believes that he is heading the procession is already lagging behind. Progress wields the bâton always, and to even march in the band means instant and hard study to keep step with the foremost.

Correspondence

What Broke the Valve?

After considering N. Olson's problem regarding rupture of a blowoff valve, described on page 309 of Aug. 31 issue, I am convinced that the accident was due to water hammer.

The conditions existing before the blowoff of No. 1 boiler was opened by the fireman probably were as follows: Some water in the pipe between *B* and the Y branch; some water in the long blowoff main caused by leaks from



ARRANGEMENT OF BLOWOFF CONNECTIONS AND DETAILS OF BROKEN VALVE

the other boilers or else held back by sediment in the blowoff main; some collection of sediment in the blowoff pipe between valve *A* and boiler No. 1.

Although the fireman may have opened up blowoff valve of boiler No. 1 at a moderate rate, the discharge of water and steam probably took place with great suddenness because partly baked sediment clogged the passages and suddenly gave way. The high velocity of the discharge past the Y branch thus caused "ejector" action, tending to draw water out of the short pipe leading to valve *B* and creating a partial vacuum.

At the time a "shock" was heard in the piping, the discharge in the main was suddenly checked, by putting sediment and "slugs" of water in motion, thus setting up a violent water hammer. Reaction due to surge, or wave set up by water hammer, thus augmented by a vacuum, would drive a "slug" of water, in the short pipe attached to the Y branch, against the valve *B* with high velocity, and the impact would put a greater strain on valve *B* than would come on valve *A*—which accounts for the rupture of valve *B*, though it was not in the direct line of reaction from water hammer. Stress due to a blow thus imparted, plus the pressure the valve was already under from boiler No. 2, might be sufficient to fracture the valve.

E. Hurst.

Montour Falls, N. Y.

I believe the rupture of the valve was due to a water hammer caused by the water in the 4-in. branch line from valve *B* to the Y at the main line. When the blowoff valve *A* was opened it created a jet action at the Y, which pulled the water out of the branch line until enough vacuum was formed to cause the discharged blowoff water to be forced into that line, resulting in enough pressure to rupture almost any valve.

I think if Mr. Olson would do away with the 4-in. branch and Y, and move valve *B* back so as to connect blowoff No. 2 with a tee as No. 1 is connected, he will avoid such trouble.

F. S. Hearne.

Hope, Ark.

Washing and Laying Up Boilers

Some interesting information under the heading, "Washing and Laying Up Boilers for the Summer," is given by J. C. Hawkins on page 277 of the Aug. 24 *Power*. When boilers are in basements in which the circulation of air is poor and where the air is damp, much more damage is possible to a boiler left open than to one completely filled with clean water free from corrosive agents. The water used to fill an idle boiler should first be passed through a heater, raising it to boiling temperature, or through a chemical purifier. If both are impossible, an analysis of the water could be obtained and the proper chemicals used to neutralize corrosive agents.

A boiler laid up for a season should be filled with water to the safety valve and not to the ordinary working level. When filled with hot water, which will contract when it cools, it should be remembered that more water must be used to completely fill the boiler. Where I am employed there are a number of boilers idle during the summer. At this time they are kept filled with water, and some of them have been in use more than twenty years and the plates are still practically free of corrosion or pitting. They are in damp rooms, and the exposed outside parts are protected in times of idleness by black japan paint. If Mr. Hawkins found so much rust and corrosion in the boilers after ten or twelve weeks' idleness, it would appear that the water had some constituent destructive to the plates. In one place he states that a small quantity of water had entered the boiler by leakage and that some pitting had resulted. This is not uncommon.

No hard and fast rules can be given for laying up, as local conditions must be met, and as these vary, the procedure must differ for best results.

Toronto, Ont. J. E. NOBLE.

How the Inspector Does It

The article, "How the Inspector Does It," on page 319, Aug. 31 *Power,* reminds me of a similar case. The fireman noticed steam rising from the top of one of the boilers, which were partly bricked over, the central top part being covered with sand about eight inches deep.

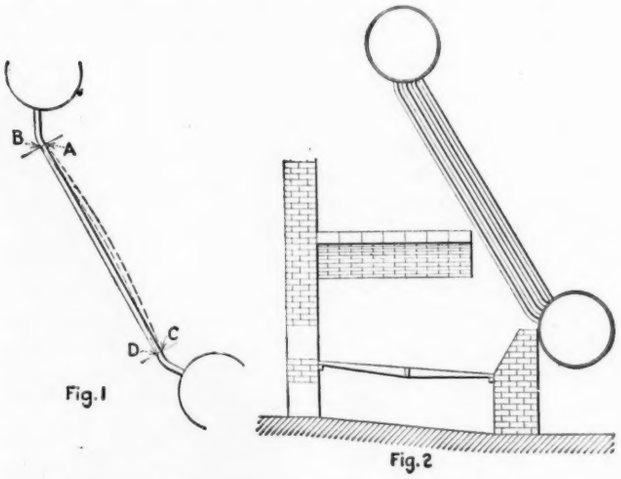
When examined, a leak was discovered where the steam connection for the water column was screwed into the shell. It had probably been leaking for a long time, as the brick and sand were damp notwithstanding the heat. A large circular part of the shell was badly rusted and corroded, and in some parts the plate was not over 1/8 in. thick. Of course, all the bad part was cut out and a large patch put on.

Toronto, Ont. J. E. NOBLE.

Boiler Tubes Have Tendency To Spring Upward

The front-row tubes of Stirling boilers are often found sprung upward, as shown in Fig. 1. Opinions differ as to what causes them to spring upward instead of downward. Nearly all of the tubes in the front pass get sprung more or less, but those on the sides not so much as the center ones, some of which get as much as 1½ to 2 in. out of line.

I believe there are at least two forces tending to spring them in this direction. First, the point at which



FIGS. 1 AND 2. SHAPE AND POSITION OF TUBES

the bend occurs is just below the arch over the dutch-oven usually built in these boiler furnaces. The end of this arch, shown in Fig. 2, is within a foot of the tubes in the middle of the furnace and the point at which the bend occurs is in the direct path of the hottest gases. The distance from the drum to the point *B* on the tube at the top and the point *D* at the bottom is greater than the distance from the drum to the points *A* and *C* on the other side of the tube, as it is the arc of a larger circle; therefore each would lengthen a greater amount from heat, which would tend to throw the middle of the tube back toward the baffle wall.

Both ends being fastened solidly, the tube is bent in its weakest place, which is just at the end of the arch, as the tubes are the hottest at that point.

Another reason for the tubes springing is that at this point the evaporation takes place so rapidly that the content of the tube is not solid water, but a mixture of water and steam bubbles, and these bubbles have a tendency to rise vertically, or to the back of the tube. Steam, however, is not so good a conductor of heat as water, and the metal on the back side of the tube will not absorb the heat as rapidily as that on the front side. Consequently the tube becomes hotter on the back which produces greater expansion. This also tends to throw the tube back in the same direction as the expansion due to the curved ends. This would be more pronounced where there is a coating of scale in the tube.

Hyattsville, Md. J. C. HAWKINS.

What Makes a Good Lubricant

Mr. Fromeyer's statements[1] in reference to asphalt-base and paraffin-base lubricants are directly contrary to the experience in the oil business. While such opinions were generally held a number of years ago, developments in the oil business since then have effectually disposed of such theories and have shown the true comparative values of different crudes for different purposes. The matter is one in which the Texas Co. is interested because some of the Texaco lubricating oils are manufactured from asphalt-base crude, but it also handles crude oil of paraffin base and is therefore just as directly interested in the values of one as of the other.

The reason for the old prejudice against anything but paraffin-base oils for lubricating is to be found in the poor results of the early experiments made in refining asphalt-base oils. These results, however, were not due to the raw material, but entirely to the lack of information and experience as to the best methods of producing the finished product. Today in the oil business, as in any other business, it is true that the character of the refining methods and the processes adopted by the manufacturer of lubricating oils have a far more important effect upon their practical use than the crude from which they are made. These refining processes must be so arranged as to bring out practically for use under technical conditions the value which there is in the crude oil only in a potential state.

In the article by Lieut. G. S. Bryan in the *Journal* of the American Society of Naval Engineers, you will find that he specifically states that "oils made from southern-asphalt-base crudes have shown themselves to be better adapted to motor cylinders so far as carbon-forming proclivities are concerned than are the paraffin-base Pennsylvania oils." This article, which by the way is quite a valuable one, deals with various other factors in connection with lubricating that indicate the absurdity of the old theories.

The Texas Co. manufactures many of its highest-grade engine and marine, as well as motor oils, from asphalt-base crude, because it has found that these oils can be manufactured so that the internal friction is greatly re-

[1] "Lubrication," "Power," May 25, 1915, page 721.

duced under working conditions and the effective lubricating increased.

It is true that a badly manufactured asphalt-base oil will produce results in a power plant which will be very unfortunate, but that is also true of a badly manufactured oil of any kind.

The fact of the matter is that the selection of an oil is dependent upon so many factors that are outside of the possibility of testing in the ordinary way, that neither specification as to tests nor definition as to source of supply is of any moment in the buying of oil for power-plant purposes. The requirements of oils for plants are dependent almost entirely upon the mechanical conditions of the plant, and the oil must be selected with these conditions in mind.

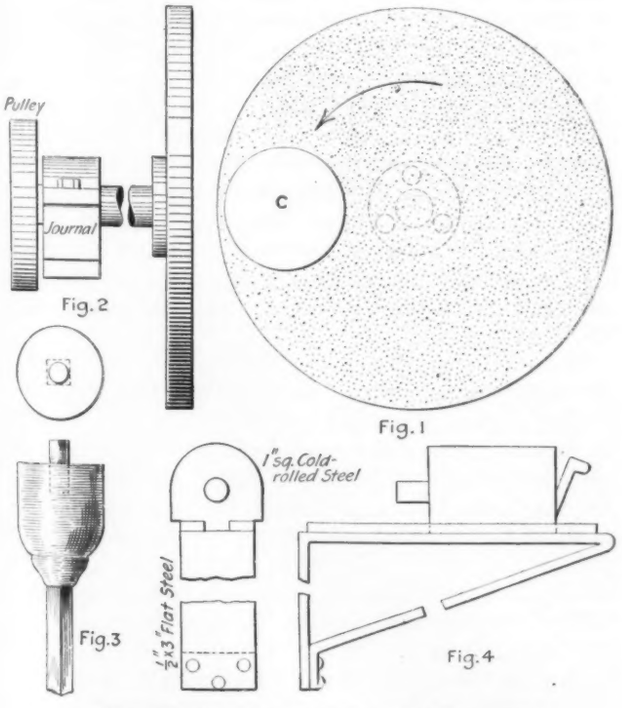
HARRY TIPPER,
Texas Co.
New York City.

Facing Up Rubber Pump Valves

Articles often appear in *Power* on the subject of truing up rubber pump valves, but most of the methods described assume either that every plant has a lathe or that there are only a very few valves to dress and no end of time to do it in.

In this plant there are twelve thousand 4½-in. valves, and it costs no more than $50 per year to dress them with the apparatus to be described.

If there is a lathe available, turn out a plate as shown in Fig. 1, glue No. 3 emery cloth or No. 36 aloxite on



EQUIPMENT FOR FACING VALVES AND OTHER SURFACES

the face by smearing the metal with glue and setting it down on the cloth, which has been placed on a smooth surface; place about forty pounds of weight on the plate and allow it to dry for two hours before using. Then chuck it in the lathe and use the holder shown in Fig. 3, clamped in the tool post to hold the valves. The holder must be set true with the faceplate, so that it brings the valve in contact with the plate as at *C*, Fig. 1. The holder is best made from a forging, and slightly larger than the largest valve to be dressed. Various sizes of center pins are made to screw in so as to fit the holes in the valves.

If there is no lathe available and a permanent machine is desired, it can be made as shown in Fig. 2, using a journal and pulley. The frame can be made of 4x4 in. oak, or the journal can be fastened to a 1-in. plate of suitable size and mounted on a concrete block. The bracket shown in Fig. 4 is a slide-rest mounted so as to bring the valves in contact with the plate, as at *C*, Fig. 1.

If only a few valves are to be dressed occasionally, a faceplate can be made to fasten to the end of the grindstone spindle or any other shaft end. The holder in Fig. 3 is then made of wood and modified so as to be held in the hand.

SAM H. FARNSWORTH.
South Chicago, Ill.

Concrete Not Suitable for Furnace Linings

The use of portland cement or concrete mixtures of cement and cinders or coal ash has been proposed in recent issues of *Power* as a substitute for fireclay or firebrick in boiler-furnace linings. From the nature of the bonding materials, however, such linings cannot be successful in high-temperature furnaces. Portland cement or hydraulic cement is not a refractory material, nor does it become a refractory when used as a binder, even with refractory materials, such as sand, clinker, ashes or broken firebrick. Portland cement, which consists largely of aluminates and silicates of calcium, sets by taking up water. This process is also known as hydration. When cement concrete is subsequently heated to a high temperature, the water is driven off again and the cement binder crumbles, regardless of what the aggregate may be. While hydraulic cement, properly handled, may do very well for chimneys and smoke ducts, it is not the proper material for furnace linings.

The refractories now universally used for boiler-furnace linings are composed of fireclay or a combination of fireclays. Other heat-resisting materials, such as silica, bauxite, chrome and magnesite, having higher refractory qualities have been tried, but because of their inability to withstand the thermal, mechanical and chemical conditions met with in boiler furnaces, have failed. Silicate is a very highly refractory material and will withstand high temperatures, but as a lining in a boiler furnace its life is short, since being of an acid nature it is quickly attacked by the basic ash of nearly all coals. A silica lining is also unable to withstand the sudden changes of temperature that occur in boiler furnaces, and rapidly breaks up and spalls off.

Experiments have been made with bauxite, but owing to the variation in the chemical composition of the material as it is found in nature and the control of the best ore fields by the aluminum industry, but little use is made of it for furnace linings. Chrome and magnesite, although excellent refractories, are unsuitable because of their inability to withstand much pressure at high temperatures or the effect of temperature changes.

The materials for boiler-furnace linings must be confined to proper combinations of fireclay rather than the substitution of a non-fractory material. Present-day practice, with high-furnace stoker-fired boilers not infrequently run at 200 to 250 per cent. overrating, demands the best of linings. However, even the most carefully laid-up firebrick or block linings bonded with fireclay are hardly satisfactory. Masons and others are prone to lay the firebrick mortar too thick, with the usual result that the fireclay crumbles and falls out, especially if it is of inferior composition. Probably the feature that appeals most to the engineer in the proposed use of cement is that it may be molded into a monolith in place and requires no special degree of skill.

A. W. Uhl.

Brooklyn, N. Y.

Locknuts Held Setscrews Tight

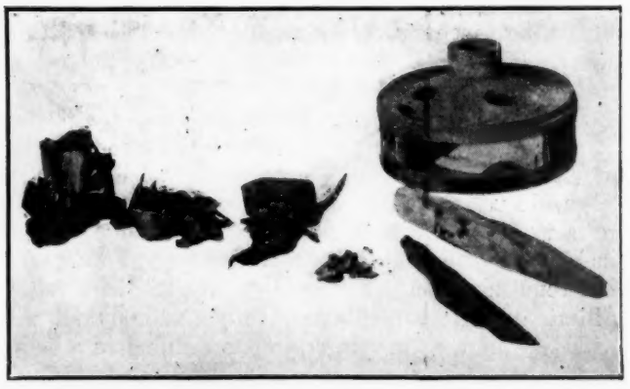
The setscrews kept working loose in a governor driving pulley on a Corliss engine, probably because it is a rather loose fit on the shaft and both setscrews are on one side, which caused the set collar to run slightly out of true. We drilled holes in the shaft approximately ¼ in. deep, to receive the setscrew points, but they persisted in working loose, so we put a locknut on each one and these have since held them securely in place.

Charles L. Juno.

Milwaukee, Wis.

Loss of Vacuum and the Cause

In a 1000-kw. turbine plant the vacuum gradually dropped 2 or 3 in. below normal, and a search for the cause was in order. Tests for air leaks at joints, relief valve, and in fact all round, failed to help matters. The suction lines and condenser were then opened, and one



CONDITION OF PUMP RUNNER AND DEBRIS FOUND

spray nozzle was found missing and another loose, indicating that they had been struck by something solid. On further examination the cause was found to be the débris shown in the lower part of the illustration, consisting of parts of an old float valve, blocks of wood, bones, and two long pieces of wood, one of which had the appearance of having been ground off at one end. This suggested an examination of the runner of the pump, and it was found in the condition shown in the illustration at the upper right-hand corner. About one-third of the blading was stripped out, and that remaining was badly bent. The damage was due to the absence of a strainer on the suction line, which, like the proverbial lock on the stable door, was afterward supplied.

F. McGough, Jr.

Albuquerque, N. M.

Paper-Mill Power Plants

In the issue of Sept. 7, page 349, Mr. Weaver refers to the fact that little has been heard from the engineers in paper-mill power plants, or of the advancement that has been made in them.

An interesting example of present-day paper-mill drive is that of a large paper company in Canada, where 200-in. paper machines (probably the largest in this country) are being belt-driven from turbines of five to seven hundred horsepower. The idea in using turbines is to procure constant peripheral speed or to avoid variations in the speed of the paper rolls and in turn in the thickness of the paper. These turbines operate at 1,200 r.p.m., twin belts and pulleys being used.

N. L. Snow.

Hartford. Conn.

Novel Pumphouse Telltale

In one of the many coal mines in this vicinity, there is a somewhat novel telltale in use, designed primarily to save shoe leather, but nevertheless interesting.

The power plant of the mine is on a slope about five hundred feet above the river from which the water-supply is obtained. The pump is located at the river side, and is electrically driven, controlled from the engine room. A large tank near the power plant provides water storage enough for a couple hours' run. On several occasions the pump has stopped because of circuit-breaker or fuse trouble, which caused the tank to run empty and compelled a temporary shutdown, as water was needed for cooling purposes in the air compressors as well as for feed-water. The electric load was too variable to depend on the ammeter for warning, and there were too many trees between the tank and engine room to permit a line and float to be used.

The engineer had no material with which to construct an electric signal system, so he contrived the following device: A small worm and gear were found and attached to the end of the pump crankshaft. A step bearing was made and placed on the floor to carry, vertically, a ¾-in. rod long enough to reach through the roof. The gear to mesh with the worm was fastened to the shaft, and a piece of tin painted white was fastened to the upper end of the shaft, extending outside, which turned very slowly while the pump was running. The engineer could see this signal from the window of the engine room and knew when the pump stopped. A pilot lamp could not be used because the lights were taken off the line ahead of the circuit-breaker. No loss of time has occurred since this telltale was installed.

F. W. Fischer.

Knoxville, Tenn.

The Production of Oil in the United States in 1914 was 292 million barrels as compared with 248 million in 1913. Of this amount 35 per cent. came from California, 7 per cent. from Texas and only 2.4 per cent. from Pennsylvania.

Inquiries of General Interest

Submergence of an Air Lift—In pumping by an air lift, what is meant by depth of submergence and percentage of submergence?

F. B. Q.

Depth of submergence is the depth at which the compressed air is liberated in the water pipe, measured from free water surface outside of the discharge pipe. Percentage of submergence, or submergence ratio, is the ratio of depth of submergence to the gross height that the water is raised above the level at which the compressed air is liberated in the water pipe.

Determination of Elastic Limit—How is the test made to determine the elastic limit of metals?

G. E. L.

The elastic limit of metals is generally ascertained by testing the specimen in a testing machine and determining the value as the stress at which the extensions begin to increase at a higher rate than the applied stresses. Some testing machines are provided with apparatus that graphically records the relative rates of elongation and of loading.

Increase of Motor Speed Due to Different Winding—Why should a 7½-hp. 220-volt shunt-wound motor of 660 r.p.m. run at 1200 r.p.m. when rewound with the same number of turns and size of wire, the field connections remaining untouched?

A. D. G.

The behavior of the motor would seem to indicate that in rewinding, the armature had been rewound with a lap winding instead of a series, thus giving only half the number of conductors in series, which on a two-pole machine would produce double the speed.

Preparing Blueprint Paper—What is a simple process of preparing blueprint paper?

A. T.

A good coating for blueprint paper is made by dissolving separately 1⅞ oz. of citrate of iron and ammonia in 8 oz. of water, and 1¼ oz. of ferricyanide of potassium in 8 oz. of water. Mix equal parts immediately before use and evenly coat one side of the paper to be sensitized, using a soft sponge or broad soft brush to obtain an even coating, and hang the paper to dry before using. The coating should be performed in very subdued light, and for drying and storage of the sensitized paper all light should be carefully excluded.

For the Same Load Lowering Initial Pressure Reduces Engine Speed—For the same load on an engine and without any change of governor, what effect will decreasing the initial pressure have on the speed?

J. G. M.

As the same resistance would require the same m.e.p., then with a cutoff engine, lower initial pressure would require a later point of cutoff, which would be satisfied by a governor position corresponding to a lower speed than the position required for shorter cutoff with higher initial pressure. With lower pressure of steam supplied to an engine having a throttling governor and fixed cutoff, the same m.e.p. is not attainable with approximately the same piston speed without a wider opening of the governor valve, corresponding with a slower speed of the governor. Therefore, with either type of governor and without changing the governor there will be a slower speed of the engine when supplied with steam at lower pressure.

Calibrating Thermometers—How can thermometers be calibrated?

W. G.

For low-temperature calibrations the thermometers to be tested may be compared with a standard thermometer by suspending them together with the standard thermometer in a water bath provided with a steam coil for varying the temperature, and a suitable stirring device. Calibrations between 212 and 400 deg. F. are best made by comparison with the temperatures of saturated steam given for different pressures in tables of the properties of saturated steam. For this purpose the thermometers to be calibrated are placed in cups, or wells, which are inserted in a steam drum and filled with cylinden oil or mercury. Pipe connections are to be made with the drum for attachment of an accurate pressure gage and valves should be placed at the ends of the drum for obtaining the test temperature by regulation of the steam pressure flowing through the drum.

Air Required and CO_2 Product for Combustion of Gas—What would be the quantity of air required and quantity of CO_2 resulting from the complete combustion of 100 cu.ft. of waste gas having the following percentages of constituents: CO_2, 12.0 per cent.; O, 0.0 per cent.; ethene or illuminant, C_2H_4, 0.1 per cent.; CH_4, 0.2 per cent.; H_2, 2.0 per cent.; CO, 25 per cent.; N_2, 60.7 per cent.?

O. P. B.

The theoretical quantity of air required and CO_2 product for perfect combustion of 100 cu.ft. of the gas would be as follows:

	Air Required, Cu.Ft.	Products, Cu.Ft. CO_2
For 12. cu.ft. of CO_2	0.000	12.0
For 0. cu.ft. of O	0.000	0.0
For 0.1 cu.ft. of C_2H_4	$14.34 \times 0.1 = 1.434$	$2 \times 0.1 = 0.2$
For 0.2 cu.ft. of CH_4	$9.56 \times 0.2 = 1.912$	$1 \times 0.2 = 0.2$
For 2.0 cu.ft. of H_2	$2.39 \times 2 = 4.780$	0.0
For 25.0 cu.ft. of CO	$2.39 \times 25 = 59.750$	$1 \times 25 = 25.0$
For 60.7 cu.ft. of N_2	0.000	0.0
Totals	67.876 Cu.ft. of air	37.4 Cu.ft. of CO_2

Size of Water Cylinders for Duplex Circulating Pump—What must be the dimensions of the water cylinders of a duplex circulating pump for handling 500 British gallons of water per minute if the slippage of the pump is 15 per cent, piston speed 50 ft. per min. and ratio of piston diameter to stroke 1½ to 1?

F. J.

A British gallon contains 277.274 cu.in., and therefore the actual pumpage required would be $277.274 \times 500 = 138{,}637$ cu.in. per min. If x = the stroke and $1\frac{1}{2} \times x$ = the diameter of the cylinders, then the displacement by two pistons would be

$$(1\tfrac{1}{2}x)^2 \times 0.7854 \times x \times (50 \times 12 \div x) \times 2 = 1674.682x^2 \text{ cu.in. per min.}$$

As with 15 per cent. slippage only 85 per cent. of the piston displacement would be realized, then

$$1674.682x^2 \times 0.85 = 138{,}637,$$

from which x, the stroke, = 9.86, and as the diameter = $1\frac{1}{2}x$ the required diameter of piston would be $1\frac{1}{2} \times 9.86 = 13.15$ in.

Locating Cause of Excessive Back-Pressure—When indicator diagrams taken from a noncondensing engine show excessive back-pressure, how can the cause be located?

P. J. B.

Excessive back-pressure may be due to obstruction to the free escape of the exhaust or to leakage of the piston or steam valves during the exhaust stroke. By taking a diagram with the indicator connected to the exhaust pipe near the engine, the same or nearly the same indication of back-pressure would signify that the exhaust pipe was insufficient in size for its length and number of elbows, or that it was improperly dripped, or was otherwise obstructed, as by a partly closed back-pressure valve, or from receiving the exhaust of other engines. If, however, the diagrams showed a decided drop in pressure below the back-pressure of diagrams taken from the cylinder of the engine, it would signify that the engine's exhaust was choked by insufficient opening of the exhaust valves, contracted exhaust passages or excessive leakage of the piston or steam-admission valves. Such leakage can be tested by blocking the engine first on one center and then on the other and observing when the throttle valve is open whether steam escapes from the indicator cocks or cylinder pet-cocks on whichever end of the cylinder the steam-admission valve should be closed. Leakage of the piston is usually best determined by admitting steam only on the crank end of the cylinder and observing the escape of steam with the cylinder head removed.

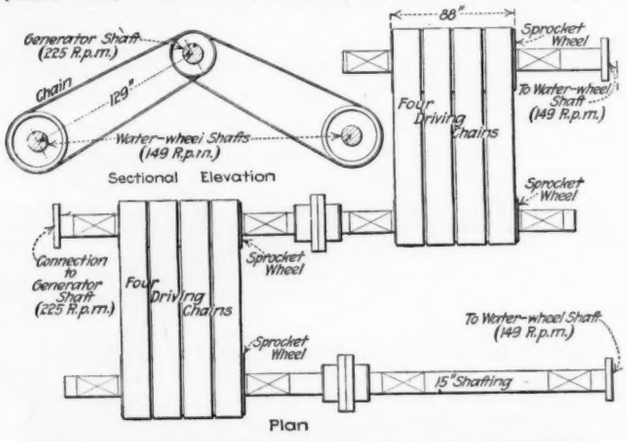
[Correspondents sending us inquiries should sign their communications with full names and post-office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Chain Drive of 5000-Hp. for Hydro-Electric Plant

The Ox-Bow hydro-electric plant on the Snake River, in Oregon, has the distinction of possessing the most powerful chain-drive gear in the world. This feature was not intended in the original design, but was introduced to adapt existing machinery to modified conditions and plans. The plant is owned by the Idaho-Oregon Light and Power Co., and is about 50 miles north of Huntington, Ore. It has been in operation for some months.

The location is at the downstream end of a sharp bend, or loop, in the river. The original project provided for a tunnel across the neck of land, the tunnel being about 1,160 ft. long and 26 ft. diameter. The floor was 10 ft. below low water at the intake end and had a fall of 1:1,000. This gave a natural head of from 20 to 22 ft., depending on the stage of the river, and was little affected by flood- or low-water conditions. In addition, a diversion dam was to be constructed about 1,000 ft. below the tunnel intake, raising the headwater level 30 ft., and thus affording about 50 to 52 ft. head.

The power plant, at the lower end of the tunnel, was designed for the installation of six units, each consisting of two pair of 48-in. waterwheels operating in open flume through center-discharge shaft tubes and direct-connected by flange couplings to a 3,600-kw. alternating-current three-phase 60-cycle generator running at 225 r.p.m. The plant



5,000-HP. CHAIN DRIVE FROM TWO WATERWHEEL SHAFTS TO A SINGLE GENERATOR SHAFT

was also to contain two 250-kw. direct-connected exciters operated by independent waterwheel units.

Financial difficulties compelled the stopping of construction when the tunnel had been finished, except for the openings from the headgates in the river. The power-plant foundations had been completed to the floor level in two units and to the spring line of the arches which were to support the floor in the remainder of the plant. Machinery had been purchased and the waterwheel apparatus delivered for three units, as was also the structural steel for the entire power plant. The dam to give the intended head had not been built. This condition continued for several years until the appointment of a receiver in December, 1913.

The receiver and the bondholders of the company employed Prof. John R. Allen, of Ann Arbor, Mich., and W. H. Rosecrans, consulting engineer, of Chicago, to examine the condition of the property and suggest some means of developing power.

With the low head available (20 ft. instead of 50 ft.), and the consequent reduction in power, the turbines could not be run at the speed required for the generators. But as the machinery had been delivered it was desirable to utilize it rather than order new equipment. Direct connection being out of the question, some form of gear transmission was considered, and the engineers recommended the installation of a single unit composed of two waterwheels and one generator, with a chain-drive transmission. This plan made it possible, with comparatively slight changes, to use the machinery already purchased. The expense was much lower than by another system of development, and only a small proportion of this expense would be lost if the plant should be altered later in accordance with the original plans.

The arrangement of the connections of this generating unit to provide for the necessary difference in speed of the waterwheels and generator is shown in the illustration. The waterwheels are placed parallel instead of in line, and the generator is slightly above them. Shaft extensions were introduced to carry the chain drive.

Each of the two waterwheel shafts carries a 71-tooth sprocket wheel 45.49 in. diameter, while the generator shaft carries two corresponding 47-tooth sprockets 30.31 in. diameter. Each pair of sprockets carries four Morse silent driving chains 31.67 ft. long and 21 in. wide, weighing about 2,800 lb. each. The pitch is 2 in. throughout. The sprockets are made in halves and bolted on the shafts, which are 129 in. c. to c. The speeds are 149 r.p.m. for the waterwheel shafts and 225 r.p.m. for the generator shaft.

The chains have been tested to a strain of 40,000 lb. per sq.in., but the maximum tensile strain under ordinary operating conditions will be 600 lb. per sq.in. It is stated that the largest chain drive previous to this was of 1,500 hp., so that this 5,000 hp. drive is by far the largest yet installed.—"Engineering News."

Columbus Refrigerating Plants

In the Sept. 7 issue, page 336, a statement was made that changes in the refrigerating plant of the Grocers and Butchers Ice Co. resulted in obtaining 16 instead of 7½ tons of ice per ton of coal.

It has since been learned that by putting in a 40-ton raw- and a 40-ton distilled-water tank and by replacing a number of steam-driven auxiliaries with equipment operated by belting from a cross-compound engine, the daily output of the plant was increased from 120 to 200 tons. The daily increase in coal consumption was only five tons. As the added capacity was 80 tons and the coal consumption only five tons more, this gives about 16 tons of ice per day per ton of coal, which must be credited to the new equipment. Results from the entire plant when running full load and continuously are about 10 tons of ice per ton of coal.

A Serviceable Coal Chart

In its report to the National District Heating Association at Chicago, June 1-3, the Station Operating Committee incorporated the accompanying coal chart.

From the proximate analysis of the coals given the chart may be used to determine the cost of steam per 1,000 lb. with various grades of coal at prices ranging from $8 to 25c. per ton and the evaporation to expect. Take, for example, Duquoin (Ill.), coal. The analysis shows that this has 82 per cent. combustible; the remaining 18 per cent. is ash, moisture and other noncombustible materials. The analysis at the right of the table also shows that this coal has 47½ per cent. of fixed carbon and 34½ per cent. volatile matter.

Referring to the left-hand side of the chart at the top, under "Percentage of Combustible in Coal" find the dotted line starting at 82. Follow this line down until a point on the vertical scale is reached reading 47½, which is the fixed carbon in the coal. Then by reading the slanting line to the left, it is found that there is 58 per cent. of fixed carbon in the combustible. From here the dotted line reaches the point 58 at the top of the chart and then passes down to the heavy line marked "Efficient B.t.u." Then by reading to the left it is found that a pound of combustible should contain about 9,200 B.t.u. As this coal has only 82 per cent. combustible, the line sloping downward is followed until it intersects the 82 per cent. on the horizontal scale. Then by reading to the right it is found that the evaporation should be about 7.8 lb. of water per pound of coal. Follow this line on through to the $2 line in the center diagram of the chart, and the price of the coal in the bin is found. From the intersection read down to the bottom of the center diagram, which shows that the coal would cost 14½c. per 1,000 lb. of steam.

At the top of the center diagram the evaporation factors have been graphically displayed. Assuming that water at 62 deg. F. is evaporated into steam at 150 lb. pressure and no superheat, it will be found by reading to the right from 62 to the slanting line representing 150 lb., that the evaporation factor is 120 per cent.; consequently the cost of steam per 1,000 lb. will be increased 20 per cent. The steam would then cost approximately 17½c. per 1,000 lb.

This chart is based on high-class operation. The top curve on the left-hand chart is based upon Du-Long's formula for figuring the B.t.u. in the combustible. The dotted curve on this same chart is the efficiency that should be obtained when burning the coal under good conditions, and the lower curve, "Efficient B.t.u.," shows what to expect from good operation.

On the right-hand side of the diagram various kinds of coal are shown and lines point to the evaporation that could be expected from this coal, so that the chart can be used

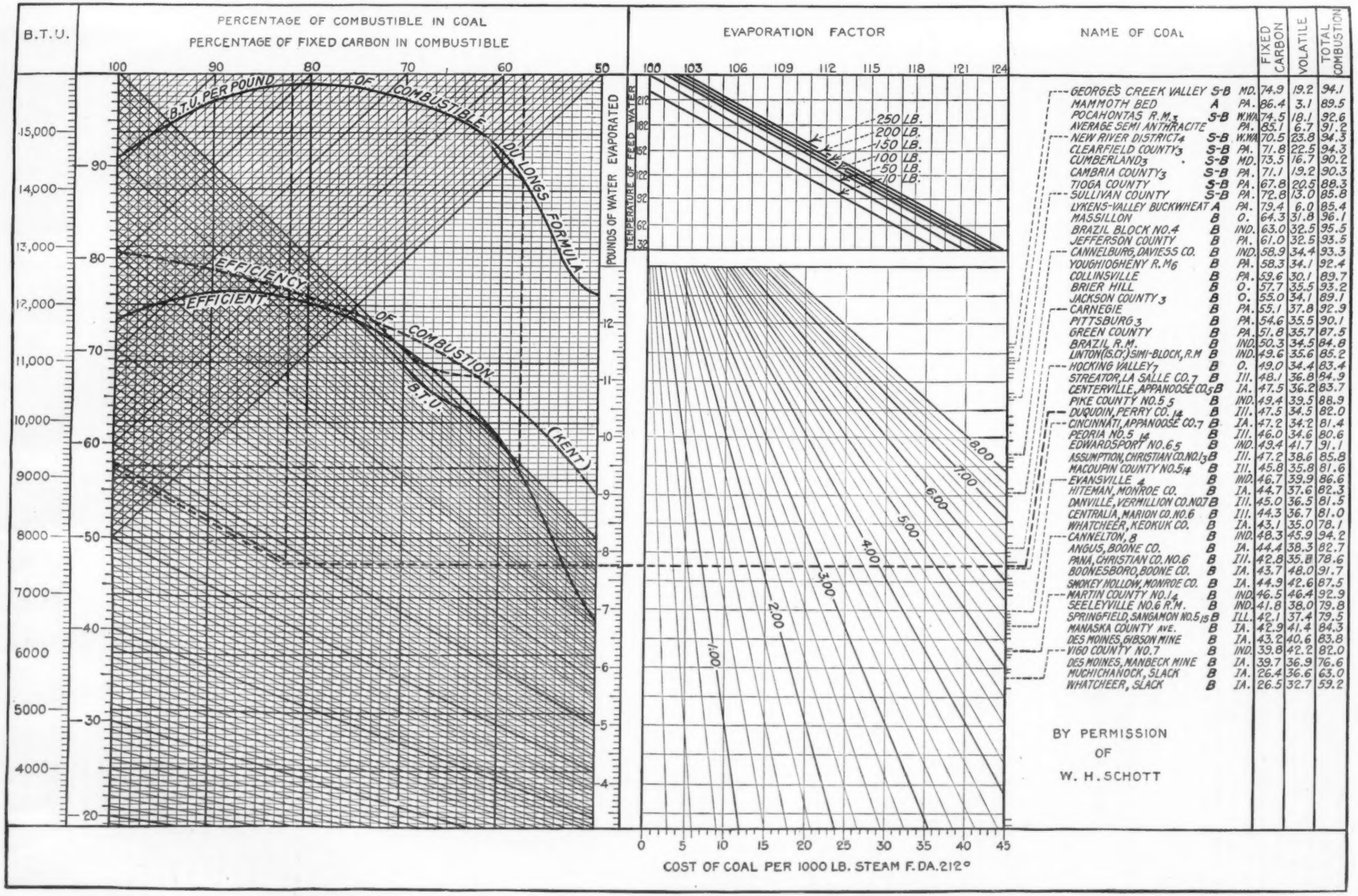

B.T.U.
PERCENTAGE OF COMBUSTIBLE IN COAL
PERCENTAGE OF FIXED CARBON IN COMBUSTIBLE
100 90 80 70 60 50
15,000 14,000 13,000 12,000 11,000 10,000 9000 8000 7000 6000 5000 4000
90 80 70 60 50 40 30 20
B.T.U. PER POUND OF COMBUSTIBLE DU LONGS FORMULA
EFFICIENCY
EFFICIENT
OF COMBUSTION
B.T.U.
(KENT)
POUNDS OF WATER EVAPORATED
TEMPERATURE OF FEED WATER
212 182 152 122 92 62 32
12 11 10 9 8 7 6 5 4
EVAPORATION FACTOR
100 103 106 109 112 115 118 121 124
250 LB.
200 LB.
150 LB.
100 LB.
50 LB.
10 LB.
8.00 7.00 6.00 5.00 4.00 3.00 2.00 1.00
0 5 10 15 20 25 30 35 40 45
COST OF COAL PER 1000 LB. STEAM F. DA. 212°
NAME OF COAL
FIXED CARBON
VOLATILE
TOTAL COMBUSTION
GEORGES CREEK VALLEY S-B MD. 74.9 19.2 94.1
MAMMOTH BED A PA. 86.4 3.1 89.5
POCAHONTAS R.M.3 S-B W.VA. 74.5 18.1 92.6
AVERAGE SEMI ANTHRACITE PA. 85.1 6.7 91.2
NEW RIVER DISTRICT4 S-B W.VA. 70.5 23.8 94.3
CLEARFIELD COUNTY3 S-B PA. 71.8 22.5 94.3
CUMBERLAND3 S-B MD. 73.5 16.7 90.2
CAMBRIA COUNTY3 S-B PA. 71.1 19.2 90.3
TIOGA COUNTY S-B PA. 67.8 20.5 88.3
SULLIVAN COUNTY S-B PA. 72.8 13.0 85.8
LYKENS-VALLEY BUCKWHEAT A PA. 79.4 6.0 85.4
MASSILLON B O. 64.3 31.8 96.1
BRAZIL BLOCK NO.4 B IND. 63.0 32.5 95.5
JEFFERSON COUNTY B PA. 61.0 32.5 93.5
CANNELBURG, DAVIESS CO. B IND. 58.9 34.4 93.3
YOUGHIOGHENY R.M6 B PA. 58.3 34.1 92.4
COLLINSVILLE B PA. 59.6 30.1 89.7
BRIER HILL B O. 57.7 35.5 93.2
JACKSON COUNTY 3 B O. 55.0 34.1 89.1
CARNEGIE B PA. 55.1 37.8 92.9
PITTSBURG 3 B PA. 54.6 35.5 90.1
GREEN COUNTY B PA. 51.8 35.7 87.5
BRAZIL R.M. B IND. 50.3 34.5 84.8
LINTON(IS.CY.)SIMI-BLOCK, R.M B IND. 49.6 35.6 85.2
HOCKING VALLEY7 B O. 49.0 34.4 83.4
STREATOR, LA SALLE CO.7 B III. 48.1 36.8 84.9
CENTERVILLE, APPANOOSE CO.5 B IA. 47.5 36.2 83.7
PIKE COUNTY NO.5 5 B IND. 49.4 39.5 88.9
DUQUOIN, PERRY CO.14 B III. 47.5 34.5 82.0
CINCINNATI, APPANOOSE CO.7 B IA. 47.2 34.2 81.4
PEORIA NO.5 14 B III. 46.0 34.6 80.6
EDWARDSPORT NO.6 5 B IND. 49.4 41.7 91.1
ASSUMPTION, CHRISTIAN CO.NO.13 B III. 47.2 38.6 85.8
MACOUPIN COUNTY NO.514 B III. 45.8 35.8 81.6
EVANSVILLE 4 B IND. 46.7 39.9 86.6
HITEMAN, MONROE CO. B IA. 44.7 37.6 82.3
DANVILLE, VERMILLION CO.NO.7 B III. 45.0 36.5 81.5
CENTRALIA, MARION CO.NO.6 B III. 44.3 36.7 81.0
WHATCHEER, KEOKUK CO. B IA. 43.1 35.0 78.1
CANNELTON, 8 B IND. 48.3 45.9 94.2
ANGUS, BOONE CO. B IA. 44.4 38.3 82.7
PANA, CHRISTIAN CO.NO.6 B III. 42.8 35.8 78.6
BOONESBORO, BOONE CO. B IA. 43.7 48.0 91.7
SMOKEY HOLLOW, MONROE CO. B IA. 44.9 42.6 87.5
MARTIN COUNTY NO.14 B IND. 46.5 46.4 92.9
SEELEYVILLE NO.6 R.M. B IND. 41.8 38.0 79.8
SPRINGFIELD, SANGAMON NO.5 15 B ILL. 42.1 37.4 79.5
MANASKA COUNTY AVE. B IA. 42.9 41.4 84.3
DES MOINES, GIBSON MINE B IA. 43.2 40.6 83.8
VIGO COUNTY NO.7 B IND. 39.8 42.2 82.0
DES MOINES, MANBECK MINE B IA. 39.7 36.9 76.6
MUCHICHANOCK, SLACK B IA. 26.4 36.6 63.0
WHATCHEER, SLACK B IA. 26.5 32.7 59.2
BY PERMISSION OF W. H. SCHOTT

CHART SHOWING THE COST OF STEAM FROM A GIVEN GRADE OF COAL UNDER VARIOUS CONDITIONS

without following through the entire diagram. For example, Hocking Valley (Ohio), coal is shown to have an evaporation of 8.1 lb. of water per pound of coal.

The basis for this chart was loaned the committee by W. H. Schott, of Chicago. The evaporation factors and the cost of steam per 1,000 lb. have been worked up by the committee. It will be interesting to notice that the curve shows nicely that the highest thermo-value occurs when the volatile matter in the combustible is somewhere around 20 per cent., ranging possibly from 16 to 24; or in other words, in the highest thermo-value coal the fixed carbon in the combustible ranges from 76 to 84 per cent.

Motor-Generators Versus Rotary Converters*

By E. Friedlaender

Prior to 1910 motor-generator sets were exclusively used in Europe; the development of rotary converters having been started there only within the last few years. In this country many improvements have lately been made in the design of rotaries, these especially bearing on the regulation, insulation, commutation, efficiency, anti-hunting devices, pole characteristics, etc., so that today we can get these machines which will operate with entire satisfaction on 60 cycles as well as on 25.

Motor-generators are mostly installed in steel-mill service for performing the double function of converting alternating to direct-current and acting as synchronous condensers. The following comparison is made between machines for transforming 6,600-volt three-phase 25-cycle alternating current to 250-volt 2-wire direct-current, or vice versa, with the variable load conditions encountered in steel plants. Standard rotaries with transformers and motor-generator sets of the two-bearing type with 6,600-volt synchronous motors (excitation current being furnished by the direct-current machine) are used.

The difference in cost between a complete installation of motor-generator sets and rotaries is so slight that it is not worth considering, although it would probably be favorable to the latter. Unless the transformers are placed in a gallery or basement—either of which would considerably increase the cost of the building and wiring—rotaries require considerably more floor space than motor-generator sets.

Where power is generated cheaply in large quantities through waste fuel, as in the steel industry, efficiency is not of vital importance. The power-factor correction feature of motor-generator sets is often of more value than the better efficiency of rotaries, the difference amounting to about 5.5 per cent. at full-load and 6.5 per cent. at half-load. Rotaries are built for 100 per cent. power factor, while motor-generator sets are rated at 80 per cent. leading power-factor.

Since the line loss varies with the square of the current, the efficiencies of the transmission lines should also be taken into consideration when comparing the total efficiencies; especially where a large number of induction motors are fed from such lines, as in such a case the improvement of the power factor by the use of synchronous motor-generator sets will greatly increase the overall efficiency of the plant.

IMPORTANCE OF POWER-FACTOR CORRECTION

In steel-mill service the inherent power factor of the system is necessarily low, because of the large number of induction motors used and the variable load conditions. Hence, raising the power factor means an advantage because it results in a first-cost saving of the transmission line and generating station, also in less line loss and higher efficiency of station, usually offsetting the difference in efficiency of the motor-generator and the rotary. A rotary converter allows only about one-tenth of the power-factor correction of a motor-generator set.

If field excitation is not properly adjusted for certain loads and power factors on rotaries, the armature windings are liable to heat. As the power factor depends on the excitation and rotaries have lagging current below full load and leading current at and above full load, their power-factor correction value is but little, especially with constant excitation and varying line voltage.

When delivering alternating current, the power-factor conditions of the system have only the same effect upon the alternating-current machine of a motor-generator set as upon any other alternating-current generator; that is, low power factor will reduce the kilowatt capacity with equal temperature rise, or increase the temperature rise with equal load. In addition to this, when a rotary is delivering alternating current, the effect of the low power factor is to demagnetize the fields and possibly make the machine run away.

REGULATION IN STEEL MILLS; LOAD FACTOR

In steel-mill service, where direct-current voltage fluctuates considerably over a wide range, motor-generator sets seem to be preferable to rotaries only from the standpoint of good regulation. The delivered voltage of a motor-generator set, either alternating or direct current, can be varied through the same limits as any other power-driven generator. The direct-current end can be compounded for any desired variation between no load and full load and the set will deliver the full rated load with a very considerable drop in alternating-current voltage.

The voltage relations between alternating- and direct-current sides of rotary converter, however, are constant and can be varied only by the use of special devices which would increase the cost, complication, operating troubles, etc., and decrease the efficiency and reliability. The effect of field strength, either shunt or compound in changing the delivered voltage depends entirely upon line conditions and not on any characteristics of the machine itself.

When delivering direct current in parallel with other sources, the motor-generator set will act as any other direct-current generator and the direct-current voltage can be varied so as to give the machine any desired load. The successful operation of a rotary under these conditions depends upon the voltage of the alternating-current side and on the voltage changes of the direct-current side. Any change in the alternating-current voltage produces a corresponding change in the direct-current; consequently, with a change in the load delivered and on account of the extreme sensitiveness of the machine, the instantaneous loads resulting are frequently of such magnitude as to open the circuit-breaker and put the machine out of service. If the alternating-current voltage drop is greater than the drop of the rotary and transformer, the rotary is liable to draw power from the direct-current side instead of delivering it.

Excessive direct-current overloads will cause a self-starting, synchronous motor-generator set to fall out of step and slow down, thus relieving it of the load. Opening the direct-current circuit-breaker allows the machine to return to synchronism and consequently it can be put back into service in a comparatively short space of time, while usually the same cause completely shuts down a rotary and requires considerable time to get it back into service.

OPERATING CONDITIONS COMPARED

The starting of both machines from either alternating current or direct current is about the same, but a rotary started up from the alternating-current side is liable to show a reversal of direct-current voltage, which is not the case with a motor-generator set. In starting rotaries from the direct-current end, it is often necessary to open the low-tension alternating-current leads, thus complicating the starting and increasing the time necessary to get it in service.

Hunting has been done away with on both types through proper damper windings and pole faces, which naturally somewhat lowers the efficiency.

Commutation of rotaries has been especially benefited through the introduction of commutating poles. The collector rings, however, carry heavy low-tension currents and are often a source of trouble and expense; whereas, the rings of a motor-generator carry only the revolving field excitation current and hence cause little trouble.

A short-circuit on the direct-current side of a motor-generator set only produces the same result that it would on any other type of interpole generator, while the low armature reaction and inherent characteristics of a rotary render it liable to serious damage from such cause. Trouble on the alternating-current side from short-circuits, surges or grounds could only result in shutting down a motor-generator set, but might result in serious damage to the direct-current side of a rotary owing to both sides being electrically connected.

If disconnected from the alternating-current and fed from the direct-current side, both types will run away on account of the series fields which are even greater on motor-generator sets. However, speed-limits, reverse-current relays and circuit-breakers must fail before a wreck occurs.

*Presented at the ninth annual convention of the Association of Iron and Steel Electrical Engineers.

Specific Resistance is the resistance from one face to the opposite face of a cube of unit size—say 1 cu.in. or 1 cu.cm.—at a given temperatures as compared with another taken as a standard.

American Association of Engineers

On Sept. 14, in the East Room of the La Salle Hotel, the American Association of Engineers held an enthusiastic booster dinner with the primary objects of creating interest in the new organization, explaining its aims and objects, and arousing enthusiasm for the first annual convention to be held at the same hotel on Dec. 10 and 11. About 140 engineers, representing the various branches of the profession, were in attendance.

The association had its inception some five months ago in the city of Chicago. Some 300 engineers (civil, electrical, mechanical, mining and sanitary) realized the need of an association which would be more or less commercial in character—an organization which would endeavor to increase the value of the engineer in the public mind and would bring up the standard of the rank and file to that maintained by other professions.

QUALIFICATIONS FOR MEMBERSHIP

According to the constitution "certified membership may be extended to any citizen, or one who has taken oath of intention to become a citizen of the United States, of good moral character, who is engaged in any branch of the sciences or technical arts, who shall be a graduate of any recognized technical school or college, who shall have had not less than two years' practical experience subsequent thereto, or who shall, in lieu thereof, have had five years' practical experience in engineering work." The procedure for certification of a member will be as follows: Upon the application blank full details are to be given as to the physical and educational qualifications and experience of the applicant. This form will be submitted to the qualification committee, who will ascertain to its satisfaction that the representations so made are a satisfactory gage of the ability of the member, and the records will be entered in the general classifications, which are tentatively as follows: Civil engineering, electrical engineering, mechanical engineering, mining engineering and all its branches, and chemical engineering. Educators are to be classified according to the engineering subjects they teach. As soon as any certified member enters his name in the service clearing-house department, the secretary will send to him notices of all new enterprises and inquiries for technical men according to their classification.

In addition the monthly bulletin which it is proposed to issue will review and list the technical articles appearing in trade and scientific journals and devote a large part of its space to an outline of interesting achievements of its members and their employers with a view to promoting their interests individually and collectively. It is also the intention to publish articles written by members on subjects of professional ethics, patent law and comments on evils, uncomplimentary and unjust conditions which may exist in the industries, educational institutions and civic organizations where the technical profession is effected.

The organization is in no sense a labor union, nor does it propose to follow their methods. No attempt will be made to regulate or stipulate salaries of members, but where practical, rates for consulting services and classified engineering work such as investigations, researches, analysis and estimates of cost requiring professional services to the general public will be classified and schedules of adopted minimums will be issued. The secretary is Arthur Kneisel, 29 S. La Salle St., Chicago.

At the dinner Toastmaster W. B. Wilcox, who is president of the association, called on a number of interesting speakers, but the principal address of the evening, entitled "The Engineer Awakes," was prepared by Prof. F. H. Newell, of the University of Illinois. The author was unable to be present, but the address was read by the secretary and the following excerpts may throw further light on the causes leading up to the formation of the new organization.

ADDRESS OF PROFESSOR NEWELL

Now is the day of awakening of the engineer as a man and as a citizen to a larger realization of his duty to society in general, to his profession, and to himself in particular. The zeal for the study of efficiency, the demand for larger and more effective organizations, the value of preparedness, all of these are being forced on the attention of the thinking man; he is seeing as never before the need of organization and of sacrificing some of his individuality in the interests of work for and with his neighbor.

The education of the engineer, whether obtained through books or through things, has been largely at the expense of some other person—either society, the state or his more immediate employers. If he is a graduate of a university or an engineering school, the cost of his education, in part at least, has been borne by the philanthropically endowed college or by taxes levied directly or indirectly for the support of a state institution. If he is not a college graduate, his early education has been more largely at the expense of his parents and to a less degree at that of his employers. It is safe to say that the majority of engineers are indebted to someone for the opportunities which they enjoy. As a body they owe a duty to the state and to society as well as to their profession.

It is this recognition of duty which gives rise to the ethics of the engineering profession and which distinguishes the engineer as a professional man from the mechanic, who from lack of this education does not feel bound to the same degree by written or unwritten codes. These ethics are well-recognized, although like many other matters of common knowledge, they are often difficult of exact definition. The conception of engineering ethics is fundamental to the profession and finds its highest expression in service.

ENGINEERING, A SERVICE TO MANKIND

Among all the various occupations there is none which is more capable of leading in service to mankind and in realizing higher ideals than engineering. The engineer should be a man of vision—a missionary of light and progress. His life is devoted to careful, impartial measurement and weighing of facts. He cannot afford to be deceived or to mislead others on these facts; having ascertained them in their true proportion, it is then his business to idealize, to plan and to use his ingenuity in devising methods for adding to the comfort and convenience of mankind, such for example, as through better conditions of transportation, of communication, of heating, lighting, water supply and of the things that tend to produce better health and longer life in the community.

In this work the engineer is far ahead of the public. The latter in many ways has not yet caught up with the growth of knowledge and does not appreciate the possibilities that are awaiting realization under the touch of the skilled engineer. The people as a whole do not as yet have the vision of better things that lie within their grasp and that can be called into being when ignorance is dispelled. The public is not wholly to blame. The engineer is to a certain extent culpable. He has not fully felt the need of diffusion of information except among his professional brothers. He has not taken the public into his confidence and explained in simple terms, in ways that would attract the public, the results already achieved, nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work affects him or how his condition may be improved.

Without attempting to discriminate between the different classes of men who may be considered as engineers, it is safe to assume that there are in North America over 100,000 men who could be classed as engineers, outside of the purely mechanical occupations. Of these over 40,000 are members of approximately 100 organizations. Of this number, 26,550 are included in the four great national societies: The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Institute of Electrical Engineers. The total just given includes duplication, but it is probably safe to assume that there are at least 20,000 such engineers, embracing most of the men that have become leaders in the profession, included in the membership above noted.

The hundred or more local engineering societies organized at the principal centers of population have a total membership aggregating in round numbers, 20,000, so that for the purpose of discussion it may be said that of the 100,000 men who claim the right to be called engineers, 20,000 are members of the four national societies with headquarters at New York. About an equal number, including many of those cited, are members of local societies, leaving over 60,000 of the men not enrolled in any engineering organization.

In this great group are men of ability and standing in the profession, but who have never seen the necessity of joining with their fellows in organized efforts. By far the greatest part, however, are the younger or less prosperous men who are performing routine work in engineering offices or engaged in the details of the country surveyor and engineer. As a whole, they include the more poorly paid professional men whose compensation averages less probably than that of the high-grade mechanics.

To this large body of engineers there is being added each year about 5,000 recruits, mainly from the engineering colleges, more or less well-trained in the fundamentals of engineering. Of course, it is necessary that many of these men go into other lines of work. They are coming into a profession apparently overcrowded. This overcrowding, however, is more apparent than real A relief is to be obtained, not by limiting the influx of men, but rather by widening the

field of service. The field is practically unlimited, the bounds extending with every improvement in the conditions favorable to human health, comfort and industry. If every taxpayer and voter in the country was fully aware of the conditions which surround him and the extent to which the engineer could remedy or improve these conditions, there would be an immediate demand for all engineers that could be found. The amount of money that is being wasted today in the amateur efforts of elected officers, who will be replaced next year by men no better qualified, would furnish employment to a large part of the engineers in the country.

OPPORTUNITIES OFFERED BY NEW SOCIETY

Summing up the needs and opportunities, it appears that a great part of the main body of engineers is not fully employed to the best advantage of society and to themselves, with corresponding loss to all. Nearly two-thirds of those that may properly call themselves engineers, or perhaps 60,000 men, are not members of any well-recognized organization and are not utilizing their potential strength to help themselves or one another. There is need of enlightenment, of raising ideals and of united effort toward better things. The existing engineering organizations, which include perhaps 40,000 men, are devoted almost exclusively to technical questions as distinct from those things that concern the engineer as an individual and a citizen. Few of the older societies attempt to bring in the rank and file of the profession or attempt to cover the field of the new American Association of Engineers in its efforts to help and reach the masses of the profession.

In the new association it is proposed to carry out the program previously outlined through five specific channels. The first of these is by affording means for the interchange of information. The second channel is that of maintaining a service clearing house. There are innumerable employment agencies and some of the larger engineering societies have undertaken in a more or less mechanical way, the diffusion of information concerning employment. There is, however, no systematic treatment of the subject such as is creditable to a body of men of the high intelligence of engineers. The third line for raising the ethics and the welfare of engineers is within a relatively new field, that having to do with patents. The fourth has to do with the supervision of legislation, seeing that proper regulations are passed and enforced. Proper publicity is the fifth channel by which the work of the engineer will be brought to the attention of the public in simple English easily understood by the layman.

Mechanical Engineers Meet at San Francisco

The trip of the Engineers' Special to the Coast went through according to schedule with a party finally totaling 159. Stops were made en route at Niagara Falls, Colorado Springs and the Grand Cañon, San Francisco being reached on the evening of Sept. 16. Representatives of the various local engineers' committees came aboard the train before its arrival at Oakland to welcome the party. The Clift Hotel was official headquarters of the mechanical engineers, the St. Francis of the civil and the electrical engineers, and the Bellevue of the mining engineers.

Thursday morning the American Society of Mechanical Engineers had its opening session in the Hall of the Native Sons of the Golden West, near the hotel. F. W. Gay, chairman of the local committee, introduced Charles C. Moore, president of the Exposition, who in welcoming the visitors testified to the debt the Exposition owed to the engineering profession, and particularly those members of it who were responsible for the design and construction of the buildings and the mechanical and electrical features. He also paid a tribute to President John A. Brashear, who has been chosen by the governor of Pennsylvania as the citizen of that state whose genius has contributed most to the general welfare. President Brashear responded modestly but appreciatively and with assurances of his own and the society's pleasure in meeting at San Francisco and enjoying the opportunity of seeing the great results that have been accomplished in this great world's fair.

The remainder of the morning meeting was given to the hearing of two papers bearing on the Exposition—one by Guy L. Bayley, who was chief engineer of construction, and presented an extensive paper on the engineering features of its building, and the other by George W. Dickie, dealing with the features of mechanical-engineering interest in the exhibitions. The author of the paper was a member of the jury of awards and chairman of the departmental jury on tools for shaping wood and metals. His effort in the paper was to make it of assistance to mechanical engineers going about the Exposition in determining what might be of greatest interest to them individually. Both papers were discussed together.

At the conclusion of the session the visitors were taken in automobiles to the Exposition grounds, where luncheon was served in Old Faithful Inn. As an adjourned meeting of the forenoon the party then gathered in the Court of Abundance, where President Moore added further felicitations to his morning's remarks, dealing with the importance of engineers to such an undertaking as the Exposition, and declared it his greatest satisfaction to honor the engineers' congress above any of the eight hundred-odd that have been held here since the fair opened. Concluding, he presented the society, through its president, with a bronze plaque commemorative of the occasion, and Dr. Brashear received it with a further expression of his appreciation of the sincerity of the consideration that the engineers had received from the hands of the Exposition authorities.

Mr. Dickie, who presided at this meeting, introduced Prof. W. F. Durand, dean of mechanical engineering of Leland Stanford, Jr., University, who read an address on the part played by the mechanical engineers in the last century's progress. A group picture of the assemblage is herewith reproduced. In the evening the mechanical engineers were invited to attend either or two dinner-dances given by the other societies—a formal one by the electrical engineers at the St. Francis and an informal one by the civil engineers in the Old Faithful Inn.

TECHNICAL PAPERS AND DISCUSSIONS

Friday morning, at the second and final session of the mechanical engineers as an individual society, two papers on internal-combustion engines were presented first and discussed jointly. One of these had for its subject "The Heavy Oil Engine, Its Present Status and Future Development," and was presented by its author, A. H. Goldingham, who cited the progress of the oil engine since 1870. In this connection he submitted a series of indicator diagrams—one from the Priestman engine of 1888, with an initial pressure of 125 lb. and a thermal efficiency of 12.8 per cent.; another from the Hornsby-Akroyd of 1890, showing an initial pressure of 120 lb. and a thermal efficiency of 13.5; one from a De La Vergne engine of 1915, with an initial pressure of 475 lb. and a thermal efficiency of 30.5 per cent.; and one from a Diesel of 1915, with an initial pressure of 550 lb. and an efficiency of 32.5 per cent.

Following a discussion of the Diesel and semi-Diesel types in general, the author passed to points of design, citing some of the early troubles with cracked cylinder heads. These have been overcome by employing such design and material as will give a uniform wall thickness and allow for equal expansion and contraction. Discussing pistons and crossheads, he was of the opinion that in a four-stroke-cycle engine of 150 hp. and over per cylinder the crosshead is preferable.

Reference was made to an interesting type of fuel-inlet valve, used for submarine engines by the Société des Moteurs Sabathé. There are really two valves, one of the ordinary type and the other larger in diameter and loose on the former, being held in place by a spring. The arrangement is designed to effect mixed combustion by allowing two periods of fuel injection. The fuel injection from the first valve is arranged to enter the combustion space when compression is about 450 lb. and the volume is constant, with the result that the pressure instantly rises. Immediately afterward the injection of fuel from the upper passage, hitherto held in check by the larger valve, is allowed to enter the combustion space while the volume is increasing. Economy of injection air and greater efficiency are claimed for this type.

The author followed with brief descriptions of several Diesel-engine installations, giving some operating figures and attesting to the reliability of this type of prime mover by showing that some have been operating with different crude oils for periods up to eight months, day and night, without stoppage. The oil engine had been introduced into pipe-line service with satisfactory results, but had not been used to any extent in the California oil fields, although with oil from that state its economy compares with that of the steam pump.

The other paper was on "The Diesel Engine and Its Applications in Southern California," by W. H. Adams, in whose absence the secretary read the following abstract:

There are comparatively few Diesel engines in this country at present, the total horsepower being just over 100,000, but the number is increasing rapidly every month. It is being used in sizes up to 1,600 hp., in six cylinders, for propelling ships, as well as in submarines and in sailing vessels as auxiliary power. As a pumping engine it gives excellent service, and it can be used for all kinds of factory service.

The engine will burn any fuel that leaves no ash or residue. Western oils are viscous and sluggish and high in sulphur, water and ash contents, but can be used satisfactorily under

proper conditions. Some engines are working on Western oils sold as boiler fuel oil. Many are in operation in Texas, New Mexico and Arizona, using Texas and Mexican oils.

The economy of the Diesel engine is the best of all present types. With Eastern refined distillate, 39 deg. Bé., 19,525 B.t.u. per lb., the fuel consumption is about 0.4 lb. per b.hp.-hr., while with Mexican crude oil, 12 deg. Bé., 17,360 B.t.u. per lb., it is 0.5 lb.

As to cost, in small units the Diesel engine may enter into serious competition with the steam turbine when the load factor is better than 25 per cent.

H. R. Setz, referring to the life of Diesel engines as being indeterminate because they have not been in use a sufficient time as yet, thought that the nature of their parts might be a guide, as separately most of them have counterparts in other older pieces of machinery. One engine in Germany during 12 years' operation had required the renewal of only a cylinder liner and a piston. He held that 10 per cent. depreciation is too high an allowance, and he would not even recommend 6 per cent.; about 4 per cent. he believed sufficient. He suggested a systematic study of the fuel oils of this country, particularly the asphaltic-base oils. Evidently the specific gravity in degrees Baumé is not a criterion of the value of the fuel oil, nor is the water content a proof of inadequacy. It depends on the form in which the water exists in the oil; in some oils a smaller percentage is more fatal than in others. Mr. Setz would like to see the society spend some of its foundation fund for research on this subject. European practice has gone the limit in size and lightness of engines, and it now appears that more weight and greater stamina are desirable features.

C. R. Weymouth spoke of the failures of gas engines and thinks that the economy of Diesel engines is their only advantage. In Europe the high cost of coal and the excellence of their workmanship were conducive to Diesel-engine development. He regards the conditions in this country as less favorable to the best development of these engines for a good many years. He took exception to a statement in the paper that the Diesel engine is in use today in almost all places where a steam engine or a steam turbine might be used. The Commonwealth Edison Co. of Chicago is now contemplating installing a 50,000-kw. steam turbine, whereas the largest Diesel engine that he knows in this country is about 800 kw. He objected to Mr. Adams' comparison of the two types of engines as taking the Diesel engine at its best and the steam engine at its worst. Furthermore, he regretted that the paper did not give a more reliable guide to the relative costs of Diesel and steam plants.

G. W. Dickie, who was presiding officer at this session, here related how some years ago he had asked Sulzer Bros. to build a marine Diesel engine, but they declined after testing some 20 samples of California oil.

In his closure Mr. Goldingham remarked that all of the criticism was of the Diesel engine, while his paper covered other heavy-duty oil engines as well. He also mentioned that later designs of engines take care of scale in the water jackets, which had been mentioned as one objection to these engines.

The last paper of the morning, by Prof. G. H. Marx and L. E. Cutter, was presented by the former and took up "The Strength of Gear Teeth." Professor Marx explained that it covered a continuation of gear testing done at the Leland Stanford, Jr., University some years ago, and reported in a paper before the society in 1912. At that time the work was criticized for the limited scope of the tests; hence this further contribution. An abstract of the earlier paper was included. One of the author's conclusions was that the breaking strength of teeth does not fall off with increased velocity at any such rate as had been previously assumed.

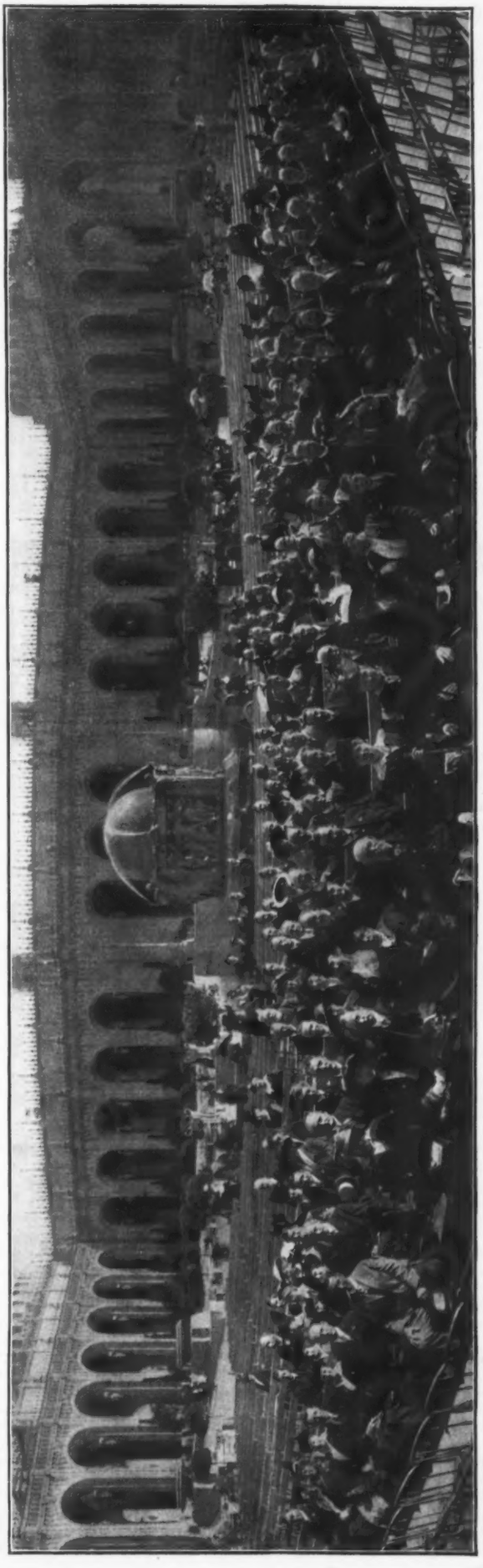
L. D. Burlingame, in discussing the paper, urged the need of investigating, as well as strength, the wear and quiet running. He would like to see some of the society's research fund devoted to this work.

Miss Kate Gleason cited the experience at the Gleason works in confirmation of the author's contention that the strength does not fall off at high speeds, but that the greater shock when starting and stopping makes it necessary to provide greater strength. The lesson from practice was that actual working conditions are not the same as test conditions.

Professor Marx, in closing, explained that the tests were under running conditions and where the question of shock or reversal of load comes in it should be taken care of in a safety factor, not a velocity coefficient.

In the period remaining between the closing of this session and the opening of the International Engineering Congress, on the morning of Sept. 20, the visitors improved the time taking in the Exposition and making various technical excursions.

The registration at the mechanical engineers' meeting was 96 members and 61 guests.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT THE EXPOSITION

Convention of the N. A. S. E.

Both in attendance and number of exhibitors, the thirty-third annual convention of the N. A. S. E., held in Columbus, Ohio, Sept. 13-18, compared favorably with other recent conventions of that body. The only unpleasantness experienced was the heat, the temperature being 90 to 96 during mid-day nearly all the week. Headquarters was at the Chittenden Hotel, the business sessions in the Chamber of Commerce Building four blocks away, and the exhibit was in Memorial Hall, another four blocks further on. The inconvenience of these locations was lessened by motor busses put at the service of conventioners by the National Exhibitors' Association.

The day of Monday was spent in escorting delegates from the depot to headquarters and in registration. During the evening a reception to the national officers was followed by the official opening of the exhibit by Louis C. Ziegler, chairman of the local committee. The speakers were Henry A. Pastre, president of the National Exhibitors' Association; Frederick L. Ray, then national president of the National Association of Stationary Engineers; Mayor George J. Karb, of Columbus; and Walter H. Damon, then national vice-president of the N. A. S. E. A band concert followed. There were 396 delegates in attendance at the convention.

Tuesday at nine a.m. the conventioners were escorted by a band from the Chittenden to Memorial Hall, where the opening exercises were presided over by Mr. Ziegler. Besides national officers the speakers were: Hon. F. B. Willis, governor of Ohio; Mayor Karb, of Columbus; and W. P. Tracy, president of the Columbus Chamber of Commerce. In the absence of Past National President James R. Coe, Past President John McGrath, of Chicago, responded to Mr. Tracy.

SOME OF THOSE IN ATTENDANCE AT THE THIRTY-THIRD ANNUAL CONVENTION OF TH

The eight necessary committees—credential, mileage, analysis and distribution, ways and means, auditing, ritual, referendum, and resolutions—were appointed. Two lectures were held in the Chamber of Commerce Hall: One on "Steam boilers," by Edward H. Kearney, past national president, and one on "The Place of the Boiler in Power-Plant Economy," by F. C. Wagner, professor of mechanical and electrical engineering, Rose Polytechnic Institute, Terre Haute, Ind. Among the recommendations of President Ray were these: That a budget of expenses be adopted covering all expenditures for the next year (a ways and means committee appointed last July took care of this); that the per capita tax be increased to 80c. per member (later the committee fixed this at 70c.); that $2,000 be appropriated for legislative work. The ways and means committee did not provide any appropriation for legislative work. It was also recommended that the educational committee enter into a five-year agreement with the International Correspondence Schools for special courses to members, the latter bearing the expense. It was recommended that $500 be contributed to the boiler-code fund of the American Society of Mechanical Engineers. This also was killed by the ways and means committee.

The report of Vice-President Damon, also a national deputy, shows that 12 new associations, with a total of 128 members, have been instituted and that 8 associations have been reinstated during the year. The secretary's report states that 292 associations reported, showing 19,562 active members.

The total number on whom per capita was paid is 20,708. The treasurer's report showed a balance of $20,169.58 on Sept. 1, 1914. The receipts for the year, including the balance and interest on it were $51,119.54. With officers and kindred expenses paid, the balance in the treasury, including the protection fund of $500, is $16,394.40. Mileage for this year amounted to $13,726.95. The ways and means committee's disbursement estimate for the coming year is $28,453.

Wednesday was outing day at Indianola Park. Including the ball game won by the engineers with a score of 18 to 7 over the supplymen, there were 13 events. Lane Thompson, of the Exhibitors' Association, and Mr. McFadden, of the local committee, managed the field events. The prizes were excellent.

The educational committee's report showed that there are 12 custodians of lecture slides distributed throughout the country. Comparatively little interest was taken in the prize competitions, both elementary and advanced. The following from the committee's report is interesting: "Strange as it may seem, the theories which have sometimes been applied to our educational features were widely shattered; out of our 20,000 membership, only ten were entrants in our prize competition, a much lower percentage in fact that in former years when questions submitted were of a more advanced nature . . . Of the ten members who sent papers five were from one association, namely, Lowell, Mass.; one from Lima, Ohio; one from Bristol, Conn.; and ten from New Britain, Conn." E. C. Wells, of Lowell, won first prize in each of four advance contests, and Ralph A. Johnson, also of Lowell, won first prize in each of three elementary contests; second prize in each of two and third prize in another.

During 1912-1913 there were 276 lectures with slides, in 1913-1914 there were 325, and during the year just closed, 400. The need of a power-plant data bureau was emphasized. Such a bureau would compile cost data on various kinds of plants and have such available for members. The property of the educational committee is valued at $4,466.89. The convention voted to allow $4,000 for educational work during the coming season, and to send out a complete printed lecture with each set of slides.

During the year the license committee was interested in license work before the legislatures of eleven states, although, unfortunately, nothing decisive was accomplished. The expenses of the committee were $1,795.70, of which $1,140.46 went to state license committees.

According to the report of the board of trustees the gross business carried during the year reached $80,805.51, a decrease of $5,664.49 from last year's gross.

The membership of the Life and Accident department, Sept. 1, 1915, was 3,484; the disbursements during the year were $3,384.88, and after transferring $2,500 to the death benefit fund, a balance of $931.34 remained in the treasury.

Besides the outing at Indianola Park Wednesday, there was plenty of amusement. Tuesday evening while the ladies attended a theater party their better-halves joined in a smoker

given by the National Exhibitors' Association; refreshments were served and among the talent was Bert Self, of the Peerless Rubber Co. Thursday afternoon the lecture by Professor Wagner, mentioned earlier in this report, was given. Despite the heat a large crowd enjoyed the entertainment given by the exhibitors in Memorial Hall in the evening. Paul T. Payne, of the Dearborn Chemical Co., was chairman of the entertainment committee and introduced the following talent: Miss May White, Lunkenheimer Co.; Miss Ida McFadden, Budd Grate Co.; Fred Hickey, Dearborn Chemical Co.; Billy Murray, Jenkins Bros.; Burton H. Mustin, Lagonda Manufacturing Co.; R. E. Jones, Crandall Packing Co.; Mr. Bierbesheimer, Peroline Co.; and Jack Armour of "Power."

By way of surprise, the Chapman Valve Co. gave a complimentary stag in honor of the incoming president, Walter H. Damon, in the large summer garden of the Kaiserhof. An excellent cold lunch, cigars and drinks were served. F. R. Low was toastmaster. Speakers attested the worth of the honored guest, while vocal and instrumental music added to the enjoyable occasion.

John Hatch, of New York City, won a handsome gold watch put up for a drawing by the Richardson-Phenix Co. of Milwaukee. Frederick L. Ray, retiring national president, was presented with two beautiful presents by the delegates and supplymen respectively. At the entertainment Thursday evening, Past-President Robert Ingelson on behalf of the engineers presented Jack Armour with a silver mounted meerschaum pipe.

In the N. A. S. E. the following officers were elected: Walter H. Damon, Springfield, Mass., president; John A. Kerley, Cincinnati, Ohio, vice-president; Fred W. Raven, Chicago; secretary; S. B. Forse, Pittsburgh, Penn., treasurer; William Krause, Passaic, N. J., conductor; L. E. Engle, Des Moines, Iowa, doorkeeper; William J. Bedard, Rochester, N. Y., trustee of the "National Engineer." James G. Beckerleg and J. D. Taylor were returned to their respective offices in the Life and Accident department.

In the Ladies Auxiliary the following officers were elected: Mrs. Gertrude P. Hunt, president; reëlected; Mrs. Margaret Flynn, vice-president; Eleanor Farmer, recording secretary; Mrs. H. E. Stone, treasurer; Mrs. Armour, conductor; Mrs. Morris, chaplain; Mrs. Tellier, doorkeeper.

The National Exhibitors' Association elected the following officers: Lane Thompson, Lunkenheimer Co., Cincinnati, president; Harry D. Raymond, A. W. Chesterton Co., Boston, vice-president; Henry Pastre, Liberty Manufacturing Co., treasurer; J. William Peterson, Richardson-Phenix Co., Milwaukee, permanent secretary. On the executive committee are the following: Paul T. Payne, Dearborn Chemical Co.; Charles Cullen, Powell Valve Co., Cincinnati, Ohio; F. N. Chapman, A. Leschen & Sons Wire Rope Co., St. Louis, Mo.; Tommy Green, Garlock Packing Co., Pittsburgh; Charles Wilhoft, New York Belting & Packing Co., and Horace Smith, Philadelphia Grease Co., Philadelphia, Penn.

The newly elected officers were installed by Dad Beckerley, past national president, at the opening of the ball, which was held Friday evening. Next year the convention will be held in Minneapolis, Minn.

Engineering Congress Opens

In the auditorium of the Civic Center in San Francisco, the much-prepared-for International Engineering Congress under the auspices of the National Societies of Civil, Mining, Mechanical and Electrical Engineers and Naval Architects and Marine Engineers, convened at 10:30 a.m., Sept. 20.

Dr. William F. Durand, chairman of the committee of management, called the meeting to order and gave a short outline of the conception of the idea of an engineering congress during the Panama-Pacific Exposition, and the work of preparation. He then introduced as honorary president of the Congress, Maj.-Gen. George W. Goethals, who presented James Rolph, Jr., Mayor of San Francisco, who in turn welcomed the visitors to the city. In his address Mayor Rolph spoke appreciatively of the work that engineers have done in rebuilding the city since the great earthquake and fire. Now, he explained, the city is so protected with an auxiliary fire system that it cannot be destroyed again by fire. He also referred to other engineering work now going on, which includes a tunnel 12,000 ft. long costing four million dollars and the building of a hydro-electric plant in the Sierras at a cost of forty-five million, to supply the city and surroundings with light and power.

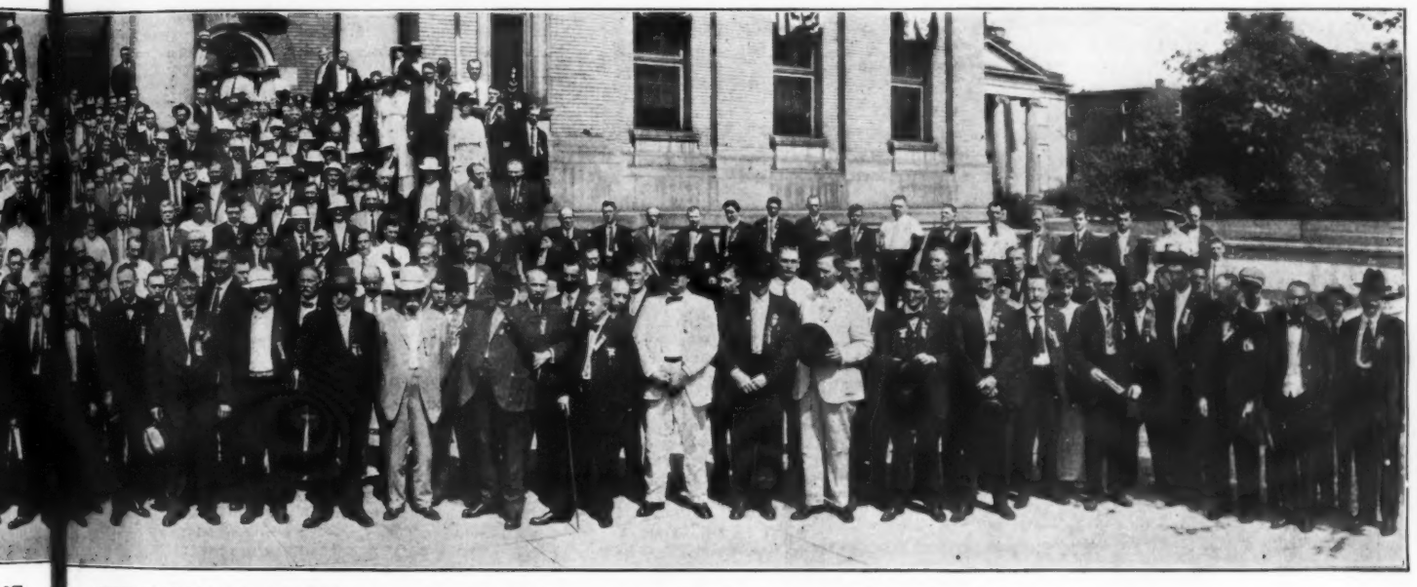
Charles C. Moore, president of the Exposition, in a short address paid tribute to the engineering profession for its accomplishments, not only in the canal work, which the Exposition celebrates, but in the building of the Exposition itself. Major-General Goethals then gave a short review of the history of the Panama Canal and its organization.

The only honorary vice-president present, Jean De Polligny, the French representative, gave his message of greetings from the French Republic, and there followed similar words from the following representatives of other countries: J. B. Challies, Canada; J. R. Vallalon, Cuba; Admiral H. W. Wei Han, China; Fernando Cruz, Guatemala; Admiral Motoki Kondo, Japan; H. J. E. Wenckebach, The Netherlands; Alejandro Canton, Nicaragua; Senor Lasarte, Spain; Richard Bernstrom, Sweden, and A. E. Rohn, Switzerland. A telegram of regrets at its inability to be represented was read from the Electro-Technical Association of Italy, and greetings from the assistant secretary-general of the Pan-American Scientific Congress to be held in Washington next December.

Following a few announcements, the meeting adjourned until the afternoon, when the congress assembled to consider the symposium of papers relating to the Canal.

In the evening a reception was given to the visiting members in the Palace Hotel.

A further account of the Congress will appear in next week's issue.



THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS, COLUMBUS, OHIO, SEPT. 13-18

In Covering Steam Piping it is often the practice to omit the covering from the flanges and sometimes from the valves and fittings. While the heat thereby lost may or may not represent an item equal to the cost of the covering and labor, the expansion and contraction effect will eventually result in damage to the piping.

PERSONALS

H. C. Baynard, formerly assistant manager of sales for the Nelson Valve Co., Philadelphia, has resigned to accept a position in the sales department of the Chevrolet Motor Co., Philadelphia.

ENGINEERING AFFAIRS

A Safety Conference is being held at the Panama-Pacific Exposition, Sept. 27-30, under the auspices of the Industrial Accident Commission of the State of California and the San Francisco Local Council of the National Safety Council. The various stages of accident-prevention work are being treated by speakers from among the ablest safety engineers in the United States.

The American Society of Heating and Ventilating Engineers held its semiannual meeting Sept. 16 and 17 at the Marlborough-Blenheim Hotel, Atlantic City. The program included the following papers and reports: "Determination of Pipe Sizes for Hot-Water Heating Systems," by Prof. F. E. Giesecke, of the University of Texas; "Apparatus for the Study of Heat Radiation," by Prof. J. D. Hoffman; "Can We Locate the Neutral Zone in Heated Buildings?", by J. J. Blackmore; "Engineering Data for Designing Furnace Heating Systems," by Prof. A. T. Willard; committee report adopted by the New York Chapter on "Profession's Efficiency and Welfare," and also a report from the committee appointed to coöperate with the National Fire Protection Association.

The American Institute of Electrical Engineers has elected Frank J. Sprague and Benjamin J. Lamme as its representatives on the Naval Advisory Board, the personnel of which was recently announced by Secretary of the Navy Daniels. Mr. Sprague is widely known for his pioneer work in the development of the electric light, the application of electric motors to stationary work, and in the building of the first electric trolley. He is at present consulting engineer of the Sprague Electric Works, the Otis Elevator Co. and the General Electric Co. Mr. Lamme, in May, 1889, entered the testing department of the Westinghouse Electric and Manufacturing Co. He has been a leader in the development of alternating-current apparatus, including the induction motor, polyphase generators, rotary converters, and single-phase railway apparatus, and in the development of direct-current apparatus for railway-lighting and power work. He was made assistant chief engineer of the Westinghouse company in 1900, and since 1903 has been chief engineer.

NEW PUBLICATIONS

TREATISE ON USE OF BALL BEARINGS

"The Use and Abuse of Ball and Roller Bearings" is the title of a new twenty-page treatise by F. J. Jarosch, chief engineer of the Bearings Co. of America. The text gives information regarding the selection, mounting and lubrication of ball and roller bearings on automobile gears and on all other rotating parts. Nineteen line drawings are used to illustrate the text matter. Copy of this treatise may be obtained free upon request, from the publishers, the Joseph Dixon Crucible Co., Jersey City, N. J.

PSYCHROMETRIC TABLES FOR COOLING-TOWER WORK

The Wheeler Condenser & Engineering Co. has issued a little 55-page book which includes both its previously published steam tables and some new psychrometric tables. The latter are based on readings from an alignment chart calculated by Prof. H. L. Parr, of Columbia University, and give the dry- and wet-bulb thermometer readings, dew point, humidity, and the pounds of water vapor per thousand cubic feet and per hundred pounds of air for dry thermometer readings from 32 to 140 deg. F. The book also contains a discussion of humidity, a description of the sling psychrometer and examples of the use of the tables.

BOOKS RECEIVED

STEAM-BOILER ECONOMY. By William Kent. John Wiley & Sons, Inc., New York. Second edition. Cloth; 717 pages; 6x9 in.; 287 illustrations; tables. Price, $4.50.

STEAM POWER. By W. E. Dalby. Longmans, Green & Co., New York. Cloth; 760 pages; 6¼x9½ in.; 258 illustrations; tables. Price, $6.

THE CALLENDAR STEAM TABLES. By H. L. Callendar. Longmans, Green & Co., New York. Cloth; 39 pages; 5½x8½ in.; steam diagram in pocket. Price, 80c.

TRADE CATALOGS

The James Leffel & Co., Springfield, Ohio. Catalog No. 65. Engines, boilers. Illustrated, 32 pp., 8½x11 in.

Kerr Turbine Co., Wellsville, N. Y. Bulletin No. 55. Economy steam turbines. Illustrated, 42 pp., 6x9 in.

Jefferson Union Co., Lexington, Mass. Catalog A. Unions, flanges, pipe fittings. Illustrated, 32 pp., 6x9 in.

Venn-Severin Machine Co., 1317-1321 North Ave., Chicago, Ill. Catalog. Oil engines. Illustrated, 36 pp., 6x9 in.

De La Vergne Machine Co., Foot E. 138th St., New York. Bulletin No. 142. Type DH oil engine. Illustrated, 12 pp., 8½x11 in.

The Lagonda Mfg. Co., Springfield, Ohio. Catalog Z-1. Vibrator cleaners for return tubular boilers. Illustrated, 12 pp., 6x9 in.

American Well Works, Aurora, Ill. Bulletin No. 141. Methods of Constructing Large Capacity Deep Wells. Illustrated, 40 pp., 7½x10½ in.

The Wm. Powell Co., Cincinnati, Ohio. Powell appliances for gas, gasoline and oil engines, motor boats, motor trucks Illustrated, 56 pp., 5x7½ in.

NEW EQUIPMENT

Buffalo, N. Y.—Delaware, Lackawanna & Western R.R. will build one-story substation at 60 Ohio St., Buffalo. Cost, $8,000.

Flemington, N. J.—Reported that Pennsylvania R.R. contemplates a power plant in connection with the electrification of Flemington-Lambertsville line.

Paterson, N. J.—Board of Estimate appropriated $5,686 for electric-light and power plant in High School building. Equipment will consist of two 135-kw. units.

Madisonville, Tenn.—Town granted franchise to M. C. King and associates, Copperhill, Tenn., for electric-light system in Madisonville.

Athens, Ohio—Athens Electric Co. contemplates rebuilding entire distribution system, and extending new transmission lines throughout the city. Page C. Morris, Vice-Pres. and Gen. Mgr.

Green Camp, Ohio—Village will build 4-mile transmission line and install street-lighting system. H. O. Fisher, Toledo, Engr.

Cheboygan, Mich.—Cheboygan Electric Light & Power Co. will install 250-hp. plant adjoining gas plant for emergency use and in low-water periods. F. B. Spencer, Secy. and Mgr.

Detroit, Mich.—Reported Hudson Motor Car Co. purchased site for new power plant and engine room.

Iron Mountain, Mich.—Peninsular Power Co. will enlarge and improve its power plant at cost of $50,000.

Chariton, Iowa—Union Service Co., Chariton, granted franchises by towns of Lucas and Woodburn to supply electricity in both towns. Energy to be furnished from Chariton. Reported that company will build new plant in Chariton.

Wall Lake, Iowa—Bonds for $7,500 voted for transmission line from Lake View and distribution system in Wall Lake. Energy will be purchased from Sac City Electric Co.

Havensville, Kan.—Town will vote for bond issue of $8,000 for electric-light plant in Havensville, and for building transmission line from Centralia.

Ord, Neb.—Reported bids will be received until Oct. 1 by John C. Work, Mayor, for electric-light plant. Estimated cost, $22,700.

Noonan, S. D.—Electric-light plant contemplated for Truax mine, near Noonan.

Tower, N. D.—City Council contemplates electric-light plant.

Soper, Okla.—Bonds for $6,000 voted for electric-light plant. Reported bids will soon be asked.

Ft. Collins, Colo.—Reported that bids are being received for power house at State Agricultural College, Ft. Collins. Cost, about $20,000. Fisher & Fisher, Century Bldg., Denver, is Arch.

Liverpool, N. S.—Reported bids will soon be received for improvements to municipal electric-light plant. Estimated cost, $15,000. T. R. Bartling, Town Engr.

Toronto, Ont.—Hydro-Electric Power Commission of Ontario decided to construct 60 miles of transmission lines as follows: Chatham to Petrolia, thence to Oil City, 24 miles; Cranton to Kirkton, thence to Exeter, 25 miles; Lucan to Ailsa Craig, 10 miles. W. W. Pope, Toronto, Secy. Comn.

The Formula for the Flow of Steam in pipes on page 306, Aug. 31, should be corrected to read

$$W = 87\sqrt{\frac{D\,(P - p)\,d^5}{L\left(1 + \frac{3.6}{d}\right)}}$$